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QUARRY BLAST THAT LIFTED AND SHATTERED 4,500 *TONS OF ROCK*

Protecting Mine Timbers With Gunite at Butte
E. M. Norris

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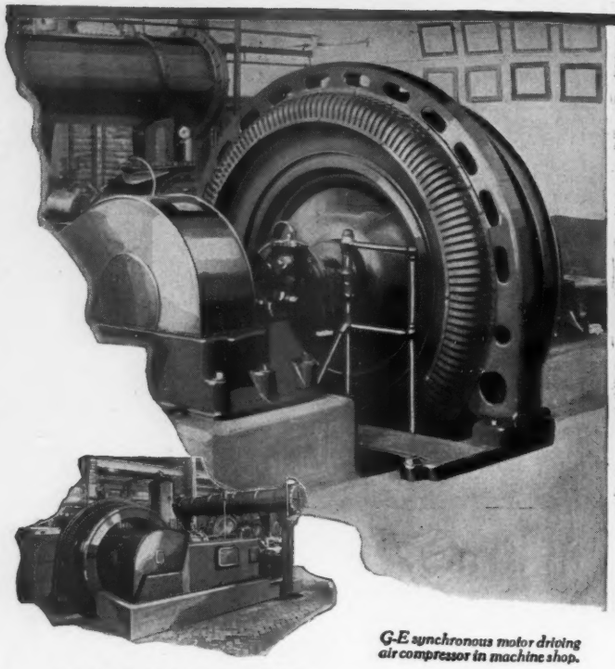
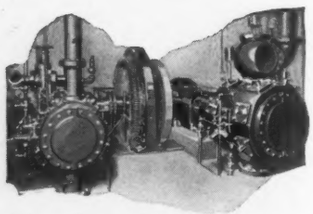


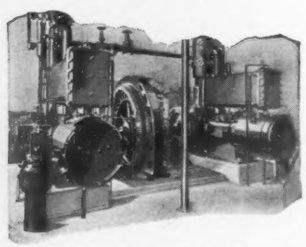
A big electrical industry uses this G-E synchronous motor for driving air compressor.

One of many installations of G-E synchronous motors driving air compressor in shipbuilding plant.

G-E synchronous motor driving air compressor in machine shop.



G-E synchronous motor driving air compressor in automobile factory.



Mining industry also uses G-E synchronous motor drive for air compressors.

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Protecting Mine Timbers With Gunite at Butte

Anaconda Copper Mining Company Has Found Gunite Coatings to be Efficacious in Fireproofing Timbers and Airproofing Rock Surfaces

By E. M. NORRIS

TIMBER is one of the essential factors in maintaining the labyrinth of mine openings in the Butte Hill. The inflammability of the timber supports, however, presented a problem which became a serious menace during the high-production period coincident with the World War. It was at this time that the cement gun came into general use,—offering a ready solution by making it possible to fireproof the timbered, main air courses of the Butte mines.

The cement gun, as most of us know, is a machine operated by compressed air by means of which sand and Portland cement are mixed with water and sprayed in liquid form upon prepared surfaces. In this way, a layer of concrete is built up which sets quickly and forms a tough, durable coating. The gun, itself, consists of a hopper chamber, mixing chamber, mixing engine, and controls; and dry sand and cement, in the proportion of three to one, are fed into the hopper chamber; passed into the mixing chamber; and mixed and fed into a flexible hose at the will of the operator. An air pressure of from 5 to 30 pounds per square inch carries the material through the hose to a nozzle, which may be several hundred feet away from the cement gun. Just as the material is discharged from the nozzle it is mixed with sprayed water and blown into place with considerable force.

In the spring of 1917, an electric-power cable in the main hoisting shaft of the Tramway mine developed a short circuit and set fire to the timbers. Fanned by a strong air current, the blaze spread rapidly, and 200 feet of the shaft timbers were burned out before the fire was extinguished. The heating and the quenching of the rock walls caused a cave-in, which filled a large portion of the shaft and caused a suspension of mining operations for six months. After the burned-out portion of the shaft had been retimbered it was decided to fireproof it by covering the shaft and station timbers with gunite applied to metal-lath reinforcing. To this end, the shaft timbers were first repaired and then gunited from the surface down to the 2,000-foot level in 94 days. This system of fireproofing was so successful that it was extended to the other mines of the company so that, at the present time, thirteen shafts have been gunited.

REDUCING fire hazards by coating mine timbers with concrete is a logical move in the direction of safety and likewise towards economy. The accompanying article emphasizes one aspect—that of safety—of this important subject; but mention might be made in advance of the need of conserving mine timber so that it will last as long as practicable.

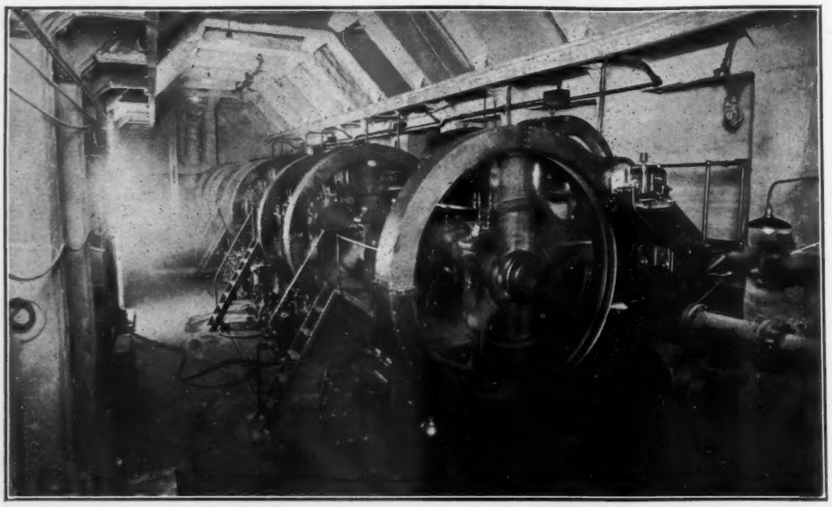
According to an estimate made by Government experts a few years ago, the consumption of mine timber in the United States in 1919 totalled 293,365,000 cubic feet. Throughout most of the metal-mining districts of the West, the consumption and the cost of mine timber have been steadily mounting; and to save money mine operators have been forced to utilize supplies of timber of acknowledged lower quality. This lays added stress upon the desirability of protecting the inferior timbering against deterioration and the attack of insects.

The author describes an effective means not only of safeguarding against the spread of fire but he also reveals how gunite can be used as a substitute for timbering and as an agency in arresting the air slaking of rock surfaces.

The shafts, which are rectangular in cross section, are from 18 to 20 feet long by 7 feet wide outside of timbers, and are from 1,800 to 3,400 feet in depth. They are timbered with 12x12-inch fir timbers framed into square sets and are placed at 4-foot intervals—that is, on 5-foot centers. The sets are lagged with 2-inch fir planks placed against the rock walls. With a few exceptions, the shafts are divided into three hoisting compartments, each 4x5 feet inside, and a pump compartment 3x5 feet inside. The latter carries the electric-power, the light, and the signal cables as well as air and water pipes.

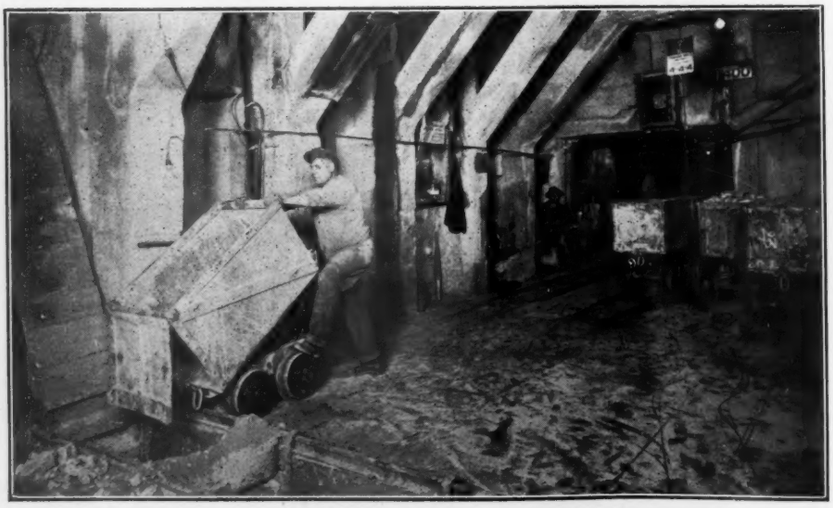
Before guniting a shaft it is put in good condition: timbers are realigned where necessary, sections subjected to heavy ground squeeze are retimbered or protected by jacket sets, and all broken or damaged timbers are replaced. The shaft is divided into 200-foot sections by heavy timber floors so placed across the compartments at station levels that one compartment is left open for a cage to supply materials to the guniting crews. The work, which is supervised by the mine bosses, is performed by three 8-hour crews, each of which is made up of 27 men, as follows: one hoisting engineer, one topman, one cage tender, twelve lathers, six cement-gun operators, and six nozzlemen. Four cement guns are used by a crew of this size. On the morning shift, two additional men are employed to operate the mixing plant, which consists of a shaking screen and a stationary cone mixer. The sand, screened through a one-fifth mesh, is charged into the upper cone of the mixer together with the proper proportion of screened cement—1 to 3; and horizontal sliding gates at the bottom of each cone permit the charge to be passed on to the cone just beneath. When the batch reaches the fourth or bottom cone it is discharged in a well-mixed condition into mine cars, and is thus sent down to the gun crews as needed.

The lathers are divided into three squads of four men, and every man is furnished with a claw hammer and a pair of metal shears. Each squad is assigned a 200-foot section of shaft, and the men commence at the bottom of the section and work upward from staging



High ore pump station at the 2,200-foot level, where timbers are protected by a coating of gunite.

Operating a cement gun in which the materials are mixed and blown under air pressure through hose to the point of application.



Station at the 1,400-foot level in Leonard Shaft where gunite-coated timbers can be seen.

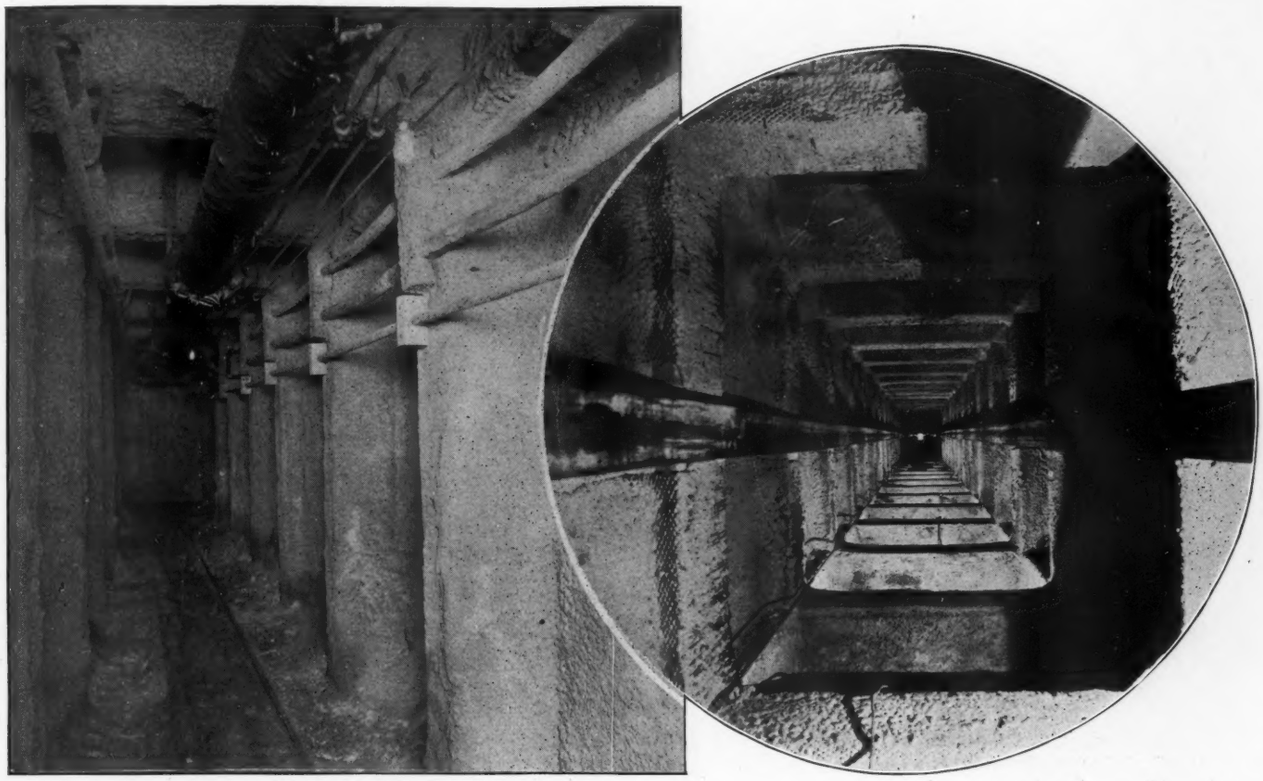
placed across the shaft sets. The metal lath, which is cut on surface into 1x4-foot and 2x4-foot strips, is fastened to the timbers with 6-penny nails; and all exposed surfaces are covered with it.

As soon as a section has been lathed it is turned over to the cement-gun crews. Two, Type N1 cement guns are stationed at the bottom of the section to be gunited, and two runners are set to operate these guns while a third man shovels in the sand-cement mixture. With these preparations completed, two nozzlemen, one to a nozzle, begin to spray the liquid cement on the lathed timber surface. When the first coat "has taken"—about five minutes after applying—a second coat is put on; and in this fashion the gunite covering is made from one-half to three-quarter inch thick. A third nozzleman assists and relays the others—the nozzle party working upward on staging. Each set is completed as they go. A small percentage of the material rebounds and falls on the bulkhead below; but this loss is kept down to 15 per cent. by the use of damp sand —10 per cent. moisture—and by low air pressure in the mixing chamber. Such a gun squad of six men with two cement guns can cover about 24 linear feet in a 4-compartment shaft, or 2,400 square feet of surface, per 8-hour shift. After a section has been gunited it is kept damp by spraying with water for several days.

An accompanying illustration shows one of the main hoisting compartments of the Leonard shaft, looking upward from the 1,000-foot level. This shaft was gunited four years ago. While falling rocks from overloaded skips have chipped off the gunite from the vertical faces of the wall plates and centers the fireproof qualities of the shaft have not been seriously affected. In this shaft, a short distance below the foreground in the picture, an electric cable formed a short circuit and set fire to the shaft ladders; but owing to the fireproofing, the flames were easily extinguished without damage to the shaft timbers. A number of accidental fires and experiments have further demonstrated the fireproof qualities of gunite. Gunited timbers have been heated to a point where the concrete covering was kept red hot for 30 minutes without damaging it and but slightly charring the wood beneath. When portions of the gunite are removed, and the exposed wood is ignited, the fire will spread for a short distance behind the gunite. After that, lack of oxygen brings about a smoldering condition that is easily controlled.

The Tramway shaft has been in service for 6½ years since it was gunited, and it is estimated that 15 per cent. of the concrete coating has been removed by falling rocks, acid ground water, and distortion of the timbers by squeezing ground. The depreciation is greatest in the main hoisting compartments; but in the pump compartment, where the electric cables are placed, the gunite is practically intact.

The upcast air shafts are lined with cast-concrete slabs, which form a smooth facing in each compartment. These smooth surfaces tend to reduce air friction; and the volume of air exhausted is almost doubled. It has been



Left—Gunited timbers in the East Colusa crosscut. Right—Leonard Shaft, looking up toward the surface from the station at the 1,000-foot level. The timbers have been gunited.

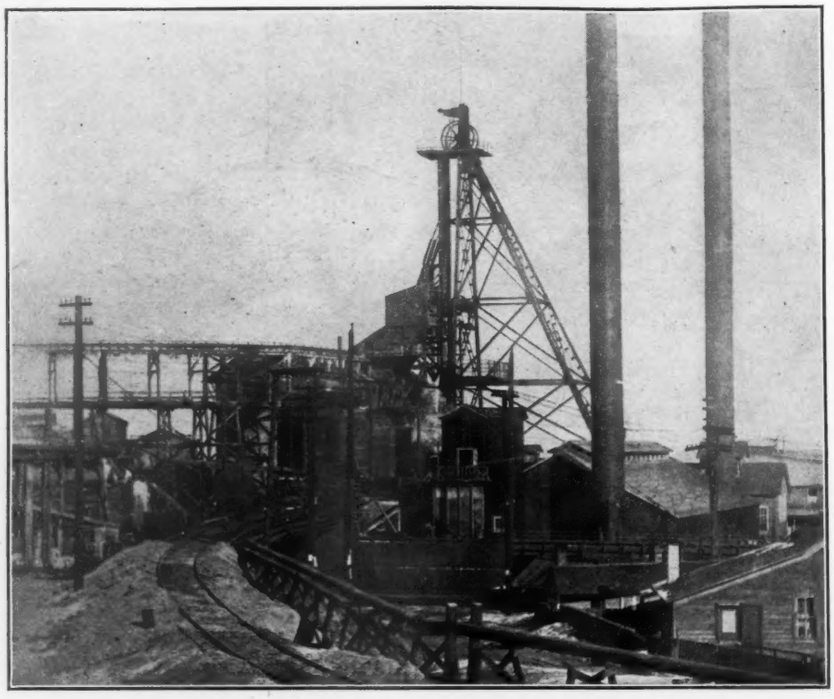
determined that this method of fireproofing is very desirable for air shafts but not so practical for shafts through which the underground crews are hoisted and lowered.

The shaft fireproofing has been made more effective by guniting all wooden structures adjoining the mine shafts on the surface, including the subways which carry the steam and electric power lines. Furthermore, guniting has been extended underground to shaft stations, pump stations, fan stations, transformer stations, crosscuts carrying electric power cables, in short to all places where electric equipment is installed. In the Butte mines of the Anaconda Copper Mining Company, 3,500,000 square feet of gunite has been applied as a fireproofing to timber surfaces. Nothing definite is yet known about the endurance of this concrete coating; but from present experience a life of from seven to ten years seems to be a conservative estimate. Failure of gunite, which has occurred, is confined to scattered patches of from three to fifteen square feet in area and is directly attributable to abrasion, produced by moving objects such as rocks, cages, cars, etc., and to seepage of water between the timber and the gunite covering. Moisture corrodes the nail fastenings, and may thus cause slabs of gunite to break off if there is any movement of the timber to which it is attached.

As a consequence of this work at Butte, another use for gunite has developed that presents very interesting possibilities. We refer to the employment of gunite as a substitute for timber. In carrying out the system of fire-

Crosscut where gunite is employed as a substitute for timber.

Nozzleman spraying gunite upon timber fitted with a reinforcement of expanded metal lath.



Anaconda Hill, or Leonard Surface as it is sometimes called.

proofing just described, it was the custom to remove sets of timber at intervals and to apply gunite without reinforcement to the exposed rock faces. These fire seals, as they are called, were made to prevent the spread of fire over the unprotected timber surfaces next to the rock walls. The rock so treated stood up very well, and this circumstance led to the further development of the idea.

The granite country rock in the Butte district oxidizes and sloughs in varying degrees when exposed to air and to moisture; and when the rock is badly fractured by faulting, or by subsidence due to mining operations, the sloughing is much more rapid and therefore harder to control. In the latter case, the supporting timbers are quickly broken unless they are eased off by removing the rock pressing against them. This work, as may readily be appreciated, requires more or less constant attention.

The crosscut, shown in one of our illustrations, was driven in 1915 to serve as an airway. Soon after it was completed the walls began to slough, and this meant ceaseless vigilance in order to keep the airway open. Two years later, the crosscut was given a three-quarter inch coat of gunite. The rock faces were washed off with water before guniting; and no reinforcement was used. As a result, there was no further sloughing for four years, but during the following twelvemonth the concrete began to crack and shell off in some places, and sloughing of the walls commenced again. In the summer of 1922, the loose rock was removed and the walls were given a fresh covering of gunite. At the present writing this coating is still intact.

In a number of cases, gunite has been similarly applied to stations, underground ore pockets, transfer raises, crosscuts, etc., and the results to date have been very satisfactory. As a matter of fact, the advantages of gunite as a substitute for timber are: it prevents air-slaking; it is fireproof; in some cases it is ten to twenty per cent. cheaper in first cost and many times cheaper to maintain; where a minimum of cross section is called for it saves excavating, for in the average mine tunnel or crosscut the timbers occupy about 40 per cent. of the opening; and, last but not least, it obviates the problem of timber conservation which assumes greater importance each year.

At present, the use of gunite as a substitute for timber in mining operations appears to be confined to cases where air-slaking of walls and roofs has to be controlled. The thin coatings applied offer but slight resistance to the stresses set up in rock by ground movements. However, the same thing can be said about timber supports, but the elasticity of timber provides a warning that is particularly of value in mining operations.

Undoubtedly, some form of metal reinforcement will be devised that can be economically utilized in conjunction with gunite and that will offer enough resistance to the bending moment to prevent any large mass of rock from being dislodged without first giving sufficient warning.

© Ewing Galloway, New York.

Bush hammering or tooling a wall with a pneumatic hammer to remove the marks of the board forms used in molding the concrete. By this treatment of the surface, the concrete is given the appearance of natural stone.

For the purposes of a geodetic survey in the Yellowhead Pass of the Rocky Mountains, a base line was required. As there was no level country thereabouts on which to lay it out, the base was measured on the frozen surface of a lake. Posts were set into the ice at about 55-yard intervals. The base thus established was more than 3½ miles long.

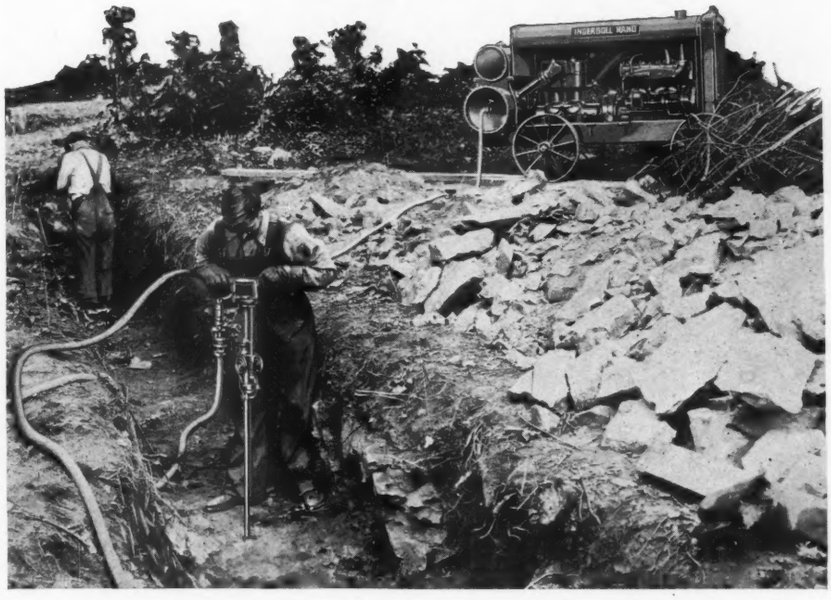
The United States lumber industry, in 1923, cut enough timber to house 10,000,000 persons comfortably, or, expressed differently, enough to rebuild three times over the 800,000 structures destroyed in France during the World War.

Increasing and Diversified Uses of Portable Air Compressors

By FRANK G. BURCH

THE PORTABLE air compressor, as we know it today, is the result of years of developmental work. The various types of these machines now available are compact, well balanced, and are capable of delivering operative air when and where required without the aid of auxiliary apparatus other than that embodied in the unit, itself.

From the standpoint of the contractor, the introduction of the self-propelled, self-contained, gasoline-engine-driven air compressor was the biggest step forward in years in his chosen field. It has made him not only independent of local sources of electric power, but he no longer has to transport the heavy equipment and fuel necessary for the operation of a steam-driven compressor. No matter where his work may carry him, the contractor can now start the operation of his pneumatic tools without the costly delay incident to making connections with electric lines or to erecting the boiler plant and getting up steam. Furthermore, in the case of the steam-driven compressor, the gage must show a working pressure whether or not the pneumatic equipment is in use. Here is a distinct saving in fuel and labor in favor of the portable, as power is developed by the latter only when needed.



Portable air compressor providing air for the operation of "Jackhamers" drilling holes in rock for a ditch excavation.

While the contractor is more or less familiar with the diversified applications of these mobile power units, it might not be out of place here to give the general reader an idea of their adaptability and their steadily widening field of usefulness. Wherever compressed air is needed for outdoor work to drive pneumatic "Jackhamers," paving breakers, clay diggers, rammers, drills, drill sharpeners, riveters, calking hammers, paint-spray outfits, etc., the portable compressor may generally be seen somewhere on the job, which may range all the way from foundation and excavation work, road building, quarrying, erection of steelwork, and assembling and repairing of smokestacks, oil tanks, and gas holders, to railroad grading, sand blasting, paint spraying, and picking ice from streets and from car tracks.

In Canada, the adoption of gasoline-engine-driven compressors has been especially marked, and dates back to August, 1922, when the first portable outfit of this kind made its appearance in Montreal. It consisted of a 5x5-inch, Type Twenty compressor, having a piston displacement of 91 cubic feet of free air per minute, direct-connected to a 15-H.P., 4-cylinder, 4-cycle, tractor-type, gasoline engine, complete with water-cooling system, and of both fuel and air storage tanks all mounted on a 1-piece, cast-steel frame securely held on a Ford truck. The machine traveled under its own power all the way from New York. It left that city on a Tuesday morning; and by three o'clock the following Thursday afternoon it was on the job in Montreal helping to lay conduits.

This portable gave a good account of itself in furnishing compressed air for the operation of two paving breakers and two "Jackhamers" employed for various purposes throughout the city. Being mobile, it made it possible to use the power plant and associate pneumatic tools in one section of the community for breaking up concrete, for example, and then to run it right over to another job elsewhere, leaving men behind to finish work that did not call for the application of compressed air. In cutting through thick stone and concrete foundations, encountered in carrying cables of various public service lines into buildings, the Type Twenty portable proved to be a great time and labor saver. As a matter of fact, it performed so satisfactorily that its owners now operate five such machines in different cities.

In Canada, the frost penetrates from four to five feet into the ground in the winter months and very often affects the service pipes where they connect with the gas mains. Before portable compressors were adopted by the Gas Distribution Department of the Public Utility Corporation, the leaks thus brought about had to be located by drilling test holes, about two inches in diameter, by hand. Not infrequently, a large number of holes had to be put down to get at the source of the trouble; and as it took two men about an hour to drill but one hole, the loss of time and the expense incurred kept the cost for this maintenance high. Today, pneumatic "Jackhamers," drawing compressed air from their

Paving breakers, drawing air from a self-propelled portable compressor unit, removing top coat of asphalt before cutting through the roadway's concrete base.

mobile bases of supply, can drill a test hole in about two minutes—in short, they can do the work of detecting gas leaks in a fraction of the time formerly required when manual labor was depended upon.

When the leak in the line has been discovered, paving breakers are substituted for the "Jackhamers." By means of these tools it is possible to cut a 2x4-foot section through 18 inches of concrete paving in 45 minutes. Just what this means in the way of speed of operation can be appreciated when it is known that two men with chisel and sledge hammer could not accomplish the same amount of work in less than a day. For the maintenance and repair of public-service lines, especially, where delay may mean discomfort to a large number of persons, the advantages of the portable are outstanding; and the records of the units in question have shown that the machines pay for themselves in short order.

Gasoline-engine-driven, portable compressor providing operative air for paving breakers engaged in cutting through a 10-inch concrete sidewalk.

Since the introduction of these portable compressors in Canada less than two years ago, units of a like capacity have also been acquired for the purpose of supplying operative air for the penumatic tools now considered indispensable in the erection of steelwork, such as buildings, bridges, tanks, etc. Aside from its mobility, the gasoline-motor-driven compressor especially commends itself for work of this kind in congested districts, inasmuch as it eliminates the smoke nuisance common to the older, steam-driven outfits.

Again, in sealing and lining the tunnel under Mount Royal, a portable, along somewhat different lines, is giving excellent results in furnishing the needful air for placing the concrete. The engine-driven compressor, which has a displacement of 210 cubic feet of free air per minute, is mounted in a box car together with a cement gun, and the entire equipment is moved along as the work progresses.

In the case of a small power-development job, where electricity was not available, it was found expedient to depend on two of these large-sized machines to drive a like number of rock drills—the point in favor of the portables being that, with the principal part of the project completed, it would be possible to set up the power units wherever desired for the necessary road-building and for subsequent repair work. These two compressors and the two "Jackhamers" were instrumental in cutting a 7x8-foot tunnel, 575 feet long, through Rocky Mountain quartzite in 84 days. And let it be remarked, quartzite is very hard, indeed.

The foregoing instances give a comprehensive idea of the practicability of self-contained, gasoline-engine-driven, portable air compressors, and also give a hint of the wide field of usefulness open to them.

Australia is at present one of our best foreign customers—standing eighth in the list of all countries to which we export.

Portable compressor furnishing air for riveting and calking a large steel tank. This outfit left New York City on a Tuesday morning and was on the job in Montreal in the early afternoon of Thursday following. A fine example of mobility.

AIR CONVEYER

IN the cloth-and-blanket mill of the J. & J. Dobson Company, Philadelphia, Pa., the wool, after it has passed through the picking process, is placed in a hopper from which a Sturtevant fan, driven by a 20-H.P. motor, blows it through a 15-inch pipe for a distance of about 600 feet to the first carding room. In that pipe there is a switch so arranged that the wool at this stage in its journey may be sent to either of two departments as required. A second fan is employed to carry the wool along to any one of five other carding rooms. Altogether, there is approximately 1,500 feet of 15-inch piping in this service; and 80,000 pounds of wool per week passes through it at an estimated labor saving valued at $5,000 yearly over and above that possible by any other method of conveyance.

BETTER VENTILATION CUTS MINERS' INSURANCE

A CERTAIN metal-mining community in the United States had, for many years, a high death rate from miners' consumption; but a recent survey by a large insurance company has resulted in a reduction of premiums amounting to from 25 to 40 per cent. D. Harrington, supervising mining engineer, tells about it in Serial 2551, recently issued by the Bureau of Mines.

Sufficient reason for the reduction is found in the use of wet drills and in the wide improvements made in ventilation, particularly in the extensions to working faces to which small blowers and flexible tubing now carry aplenty of fresh air. The insurance investigators found that the conditions which had so adversely affected underground workers in the past had been practically removed; and men of sound physique entering the mines today are in comparatively little danger of contracting the dread disease which hitherto has been so fatal.

Weaving Rainbow-Tinted Textiles for the Novelty Trade

In Making These Smart Fabrics an Abundance of Clean and Soft Water is Necessary

By ROBERT G. SKERRETT

"ISN'T IT BEAUTIFUL! How do you imagine it is made?"

This is the wondering question often asked and seldom answered in the shops where rainbow-colored fabrics are displayed. It is more than likely that a goodly number of our readers would be glad to know something about the processes and the painstaking work that are essential in the production of these attractive materials. Therefore, we are going to give you a glimpse of a plant which has long specialized in this exacting branch of the textile industry.

Some sports clothes, many of women's dresses, and the finer shirts worn by men are made from what are termed by the trade as "novelty fabrics." To serve their different purposes, these materials must be of a nature that will stand laundering and also hold their colors when exposed to sunlight. In short, the stuffs, while pleasing by reason of their patterns, their hues, and the delicacy of their texture, must nevertheless be reasonably durable. Only the most careful selection of yarns; the adoption of the most up-to-date processes and facilities; the use of the very best of dyes; skilful workmanship; and exacting supervision and inspection at every stage of production make it possible to realize these seemingly antagonistic demands.

For nearly 38 years, the Aberfoyle Manufacturing Company, located in Chester, Pa., has stood for excellence in the textile industry and has held its enviable position by turning out products which have always been marked by high quality and by artistic distinction. As time has gone on, the mills have increased in capacity until their looms have become numerous enough to weave in the course of a year more than 12,000,000 yards of various kinds of fabrics. Expressed in another way, enough cloth of divers sorts is manufactured during a twelvemonth to provide a carpet or runner a yard wide along each side of the Lincoln Highway from New York to San Francisco!

The activities at the Chester mills of the Aberfoyle Manufacturing Company may properly be divided into two distinct branches of the textile business. Dissimilar methods of manufacture are employed in these two prime departments; and the commodities from each of them go to entirely different fields for distribution or use. To be specific, one department is devoted to the weaving of cloth, and the other is entirely absorbed in turning out mercerized-cotton yarn for the knit-goods trade. In fact, all the mercerized yarn worked up by the Aberfoyle mills is treated in its own mercerizing plant, which is said to be one of the largest of its sort in existence.

In order to prevent confusion, it will probably be best for us to take up each department in its turn and to touch even then but the high spots of the somewhat bewildering activities. Inasmuch as the cloth, no matter what its

Fig. 1—Beaming: the hand process by which the threads of a warp are arranged preparatory to weaving. Fig. 2—"Drawing in and handing." This operation follows beaming and precedes the work of the looms. Fig. 3—Some of the numerous Crompton-Knowles automatic dobby-head gingham looms in the Chester plant of the Aberfoyle Company.

composition, can be formed only by the weaving of suitable yarns, the thread of our story should logically lead from these yarns onward. In the course of a week, the Aberfoyle mills handle substantially 400,000 pounds of yarns; and from these are made cotton, mercerized-cotton, fiber-silk, and marino goods.

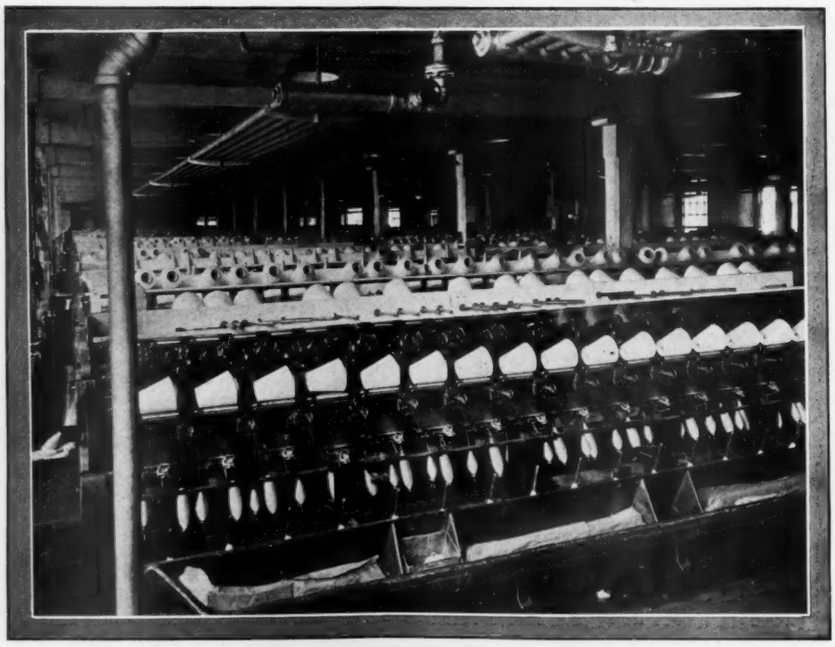
Owing to the large quantities of the yarns required, and because this phase of the business is more or less a specialty, the Aberfoyle Company has made it a practice to buy its raw materials, so to speak, from a selected group of mills which are peculiarly qualified to meet certain very exacting specifications as to weight, strength, staple, "count" —that is, size—cleanliness, and uniformity. These characteristics have a bearing on evenness in spinning and on freedom from "slubs" or soft, thick places in the goods. All cotton yarns are gray or unbleached when received at the plant; and the company maintains inspectors at the sources of supply so that it can make sure of getting the diversified yarns that are needed in the manufacture of its manifold finished fabrics.

We are all familiar with the fact that mercerized-cotton textiles have a distinctive, silky sheen which adds to their attractiveness; but beyond this only a relatively few of the millions that buy these lustrous cloths know how this effect is produced. If you ask the chemist he will probably answer —"Oh! Why that's the result of subjecting the cotton yarn to treatment in suitable solutions of caustic soda and sulphuric acid." No doubt, quite true, but not especially informative to the layman. Let us see if we cannot make the process plainer so that all of us can appreciate what is done to elevate the social standing, so to speak, of the comparatively lowly cotton fiber.

Viewed through a magnifying glass, the natural cotton filament appears not unlike a flat but twisted ribbon. This characteristic twist, by the way, helps to make cotton so easy to spin.

The busy side of a battery of quillers engaged in winding bobbins. Each machine fills 378 bobbins which, in their turn, furnish thread for winding cones.

Now mercerizing does three things: It changes to a degree the chemical get-up of the fiber; but the principal transformations wrought consist in taking the twist out of the filament and in altering the flat cross section into a round one. The acid and the alkali between them cause the central vein or core of the fiber to expand, and this action gives the filament a tubular form—the rounded surface catching and reflecting light at well-nigh every angle. In passing, it should be pointed out that the straightening of the fiber is effected by subjecting the yarn to tension while going through certain steps in mercerizing.



Winding cones with thread at the Aberfoyle plant both for its own use and for sale to other textile mills. In this department 15,000 cones are wound daily.

As a preliminary to mercerizing, after the natural-colored or gray cotton yarn is delivered to the mercerizing department, multiples of 16 warps—each warp consisting of 378 ends or strands—are bound loosely together by being wrapped with a single thread. The wrapping is done mechanically by a revolving table carrying cones of thread; and the purpose of this is to keep the yarn faggoted while undergoing mercerizing and subsequent drying. Briefly, the steps following the binding just described are: running through boiling water; passing through strong caustic soda; washing to remove caustic soda; treatment with a weak solution of sulphuric acid; removal of the acid by washing; softening operation; and then traveling between and over several stacks of steam-heated rolls which dry the yarn. From the drying rolls, the yarn is plaited or laid in boxes on wheels by a series of swinging tubes that remind one of the swaying trunks of a herd of elephants. The entire mercerizing process takes sixteen minutes—six for going through the mercerizing machine, while the ten minutes remaining constitute the drying period. This simple statement of the contributive operations utterly fails to bring out any of the niceties involved, among which are the strengths of the chemical solutions and the tension maintained on the yarn to eliminate the natural twist of the cotton filaments without weakening them.

Following the plaiting, the binding thread is removed from the faggoted warps; and then comes the splitting operation which restores the mass of yarn to its original 16 separate warps or individual aggregations of 378 strands. In the winding department, where the yarn goes after it leaves the mercerizing department, the warps are subjected to what is known as "quilling"—that is, winding on bobbins. One of our illustrations shows the machines that do this work; and each bobbin—depending upon the size or count of the yarn—

Essential Features of Water Supply System in Aberfoyle Plant

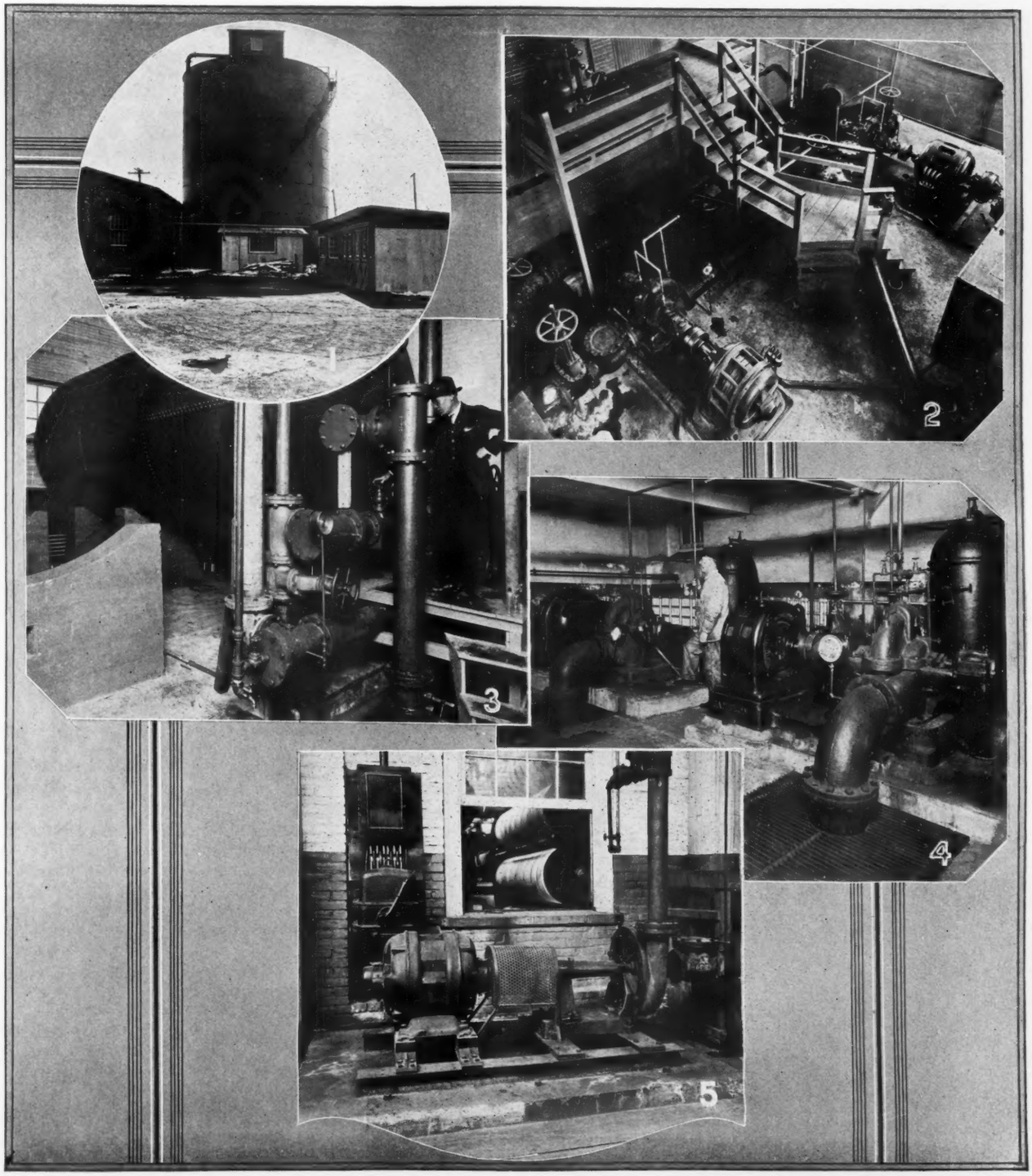


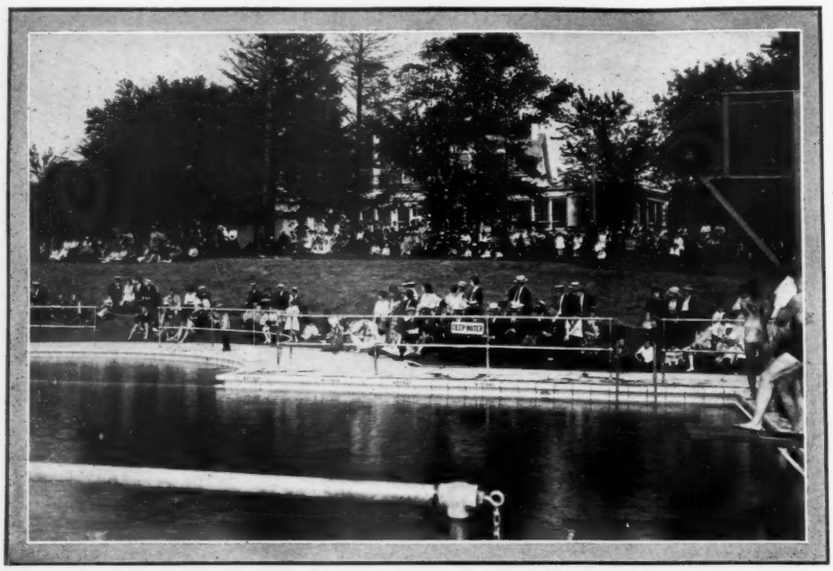
Fig. 1—Sedimentation tank, having a capacity of 50,000 gallons, which boosts the pressure and puts water through filters.

Fig. 2—Pumps Nos. 4 and 5, having a combined capacity of 4,800 gallons a minute, take water from the river and normally deliver it to the sedimentation tank.

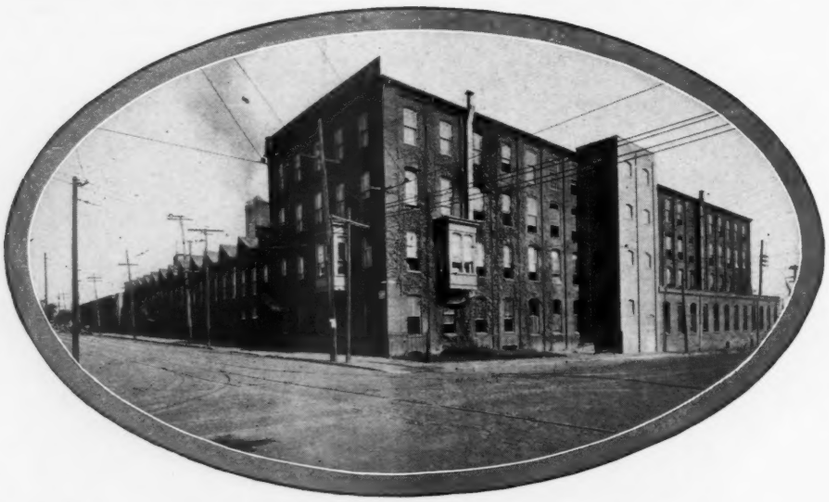
Fig. 3—The softening plant which treats all the water used in the dyeing and the finishing departments.

Fig. 4—Pumps Nos. 2 and 3 which distribute the water after it has come from the sedimentation tank, the filters, and the softening apparatus.

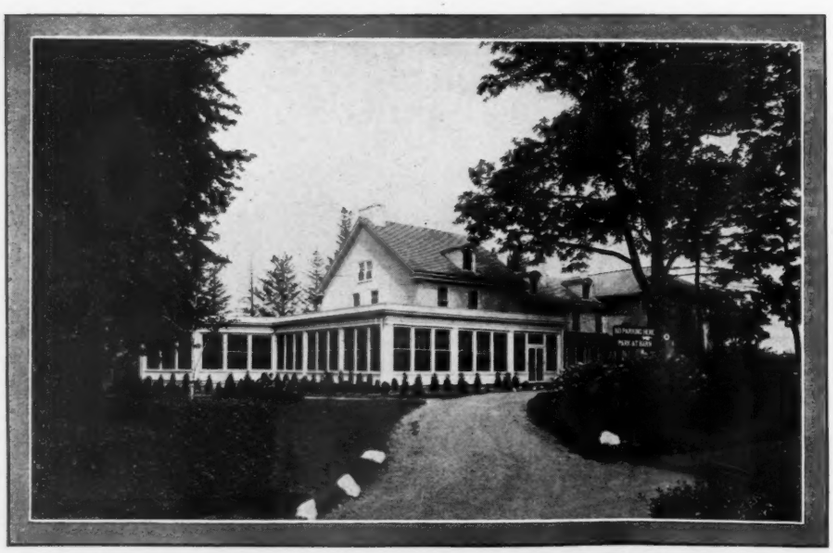
Fig. 5—Small Cameron single-suction, volute pump which handles waste liquors containing slight quantities of acid.



Swimming pool at the country club maintained by the Aberfoyle Manufacturing Company.



Main plant of the Aberfoyle Manufacturing Company in Chester, Pa.



Country club outside of Chester where the personnel of the Aberfoyle Manufacturing Company goes to play and to enjoy itself in healthful ways.

will carry anywhere from 6,000 to 7,500 yards of yarn. With the quilling done, the bobbins are placed in machines which wind the yarn onto cones, the form in which the material is distributed to textile mills for weaving. Each winding machine is capable of holding 378 bobbins on as many spindles; and it takes from 3 to 6 bobbins to fill a cone, according to the count of the yarn. A cone weighs in the neighborhood of 1¼ or 1½ pounds—a pound of yarn being enough to weave something like 18 pairs of socks. In the course of a week substantially 3,500,000 miles of yarn of average size is produced by the mercerizing and the winding departments. In other words, every six days there is turned out the equivalent of a single thread long enough to encompass the equator 134 times.

Now let us see how the Aberfoyle Manufacturing Company utilizes the yarn which it has mercerized as well as the other yarns bought ready to be worked into fabrics. In passing, we should mention that the company bleaches and dyes the yarns it uses; but space does not permit us to describe this subdivision of the cloth-manufacturing departments of the Chester mills. We shall have to be content merely to mention that the yarns are dyed with fast colors guaranteed proof against the action of sunlight and the fading effect of washing.

As explained by one of the officials: "By dyeing our own yarns we not only insure a high quality and a uniform result at a minimum of cost, but we are made independent of the standard 'color card' of some job dyers, and we are in a position to develop new shades and to reproduce the very latest shades originating in Paris or elsewhere. In this way we can keep in the forefront of Dame Fashion's procession."

Let us assume that the yarns are ready to be worked into any of the fabrics that have made Aberfoyle products famous. To understand the succeeding operations it is necessary to recall that the lengthwise threads form the warp while the crosswise threads constitute the woof or filling. The warp is the foundation of the cloth; and in making novelties such as we are considering the practice is to turn out materials in single pieces or splits having a comparatively short length of 1,380 yards. Other plants that are engaged in manufacturing staple commodities weave them in single lengths of 10,000 yards to a run. The arranging of the threads of the warp preparatory to weaving is called "beaming;" and at the Aberfoyle mills this painstaking process is done by hand by highly skilled operatives. It is a somewhat slow procedure; and the utmost care must be exercised to have all the threads in proper sequence and of the exact number or numbers agreeably to the prescribed pattern and color scheme. The threads so arranged are wound upon a cylinder, and this cylinder is transferred and placed in the loom which finally does the weaving of the filling. Before the cylinders are transferred to the weave room, nimble-fingered girls attach the ends of the warp threads to frames, which are also mounted in the loom. This operation is termed "drawing in and handing." The alter-

nating vertical movement of these frames in the loom, in conjunction with the horizontal back-and-forth flight of the shuttles containing the filling, produce the woven fabric.

The company has in its mills a total of 1,500 dobby-head looms of both plain and automatic types; and these machines turn out ginghams, cretonnes, "radioux"—a mixture of mercerized cotton and fiber silk, shirting, and various other novelty fabrics. The Chester plant is one of the few in the business that finishes its own cloth. By finishing is meant the washing and the treating of the fabrics to give them a certain appearance and "feel." In doing this work itself, the Aberfoyle Manufacturing Company is able to insure absolute uniformity of product; to prevent further shrinkage of the fabric; to do away with the employment of cheap "padding" and "loading" processes; and to obtain a virtually permanent finish by mechanical means. After the material is woven it is subjected to two thorough inspections —one before finishing and one after finishing. All defective cloth is classified as "seconds."

Enough has been said in describing the mercerizing, the dyeing, and the finishing to make it plain that water, and much of it, is necessary in the operation of the mills. As a matter of fact, 3,000,000 gallons of specially clarified water is used daily; and fully 25 per cent. of this volume must undergo a softening treatment to make it fit for the dyeing and the washing processes. Strange as it may seem, the Aberfoyle Manufacturing Company, while insisting upon the very best of yarns and dyes, was for years not so mindful of the water it used.

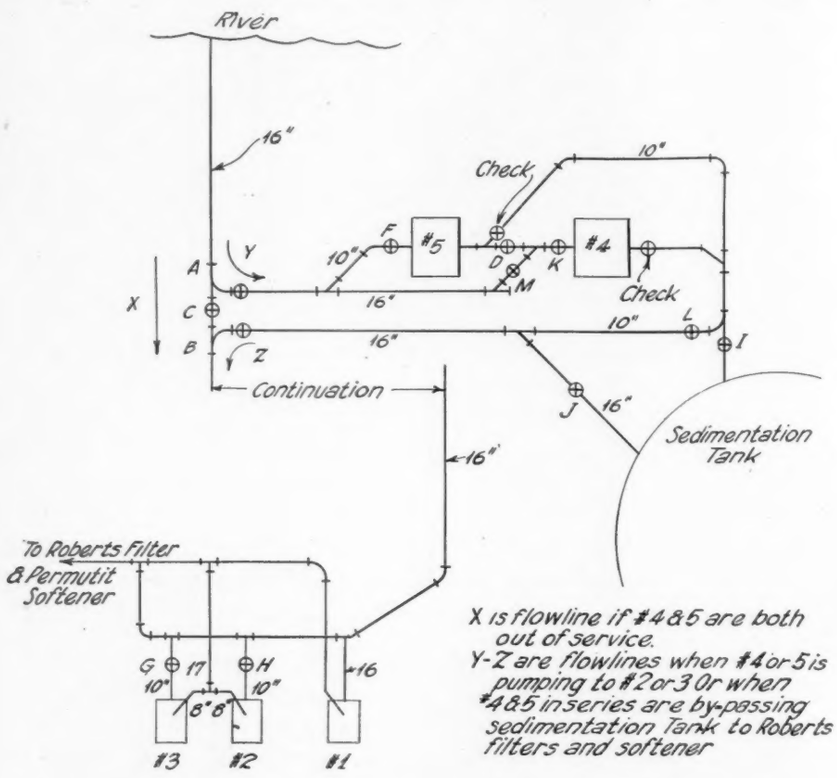
Hard water is troublesome and expensive in the end because hardness induces precipitation of the dyes and so dilutes them that more of the coloring matter is required than otherwise would be the case to insure a prescribed result. In the name of economy and uniform coloring of the textile, it is highly desirable to employ soft water; and to this end the plant is equipped with softening apparatus of sufficient capacity to satisfy these particular needs. It is more than likely, however, that the capacity will be increased so as to provide soft water for the mercerizing department where 75 per cent. of the water supply is utilized.

The importance of this phase of our subject deserves some elaboration, and the mechanically inclined reader will find facts of interest in the details that follow. The accompanying flow sheet will help to a ready grasp of the general arrangement. The main water supply, which is drawn from the Delaware River, is handled by four Cameron pumps of the double-suction, volute type, direct connected to electric motors. Using the designations adopted in the plant, Pump No. 2 is rated at 1,500 gallons per minute; Pump No. 3 is of 1,900 gallons per minute capacity; and Pumps Nos. 4 and 5 are each rated at 2,400 gallons per minute. Pump No. 2 is driven by a 75-H.P. Burke motor; Pump No. 3 by an 80-H.P. synchronous motor; and Pumps Nos. 4 and 5 are, respectively, driven by a squirrel-cage motor and a synchronous motor.

Pumps Nos. 2 and 3 were installed in 1920 to take care of the increased demand for water which the then-existing reciprocating pump could not handle. The squirrel-cage-motor-driven unit was intended to operate at times when the plant load was light so that the power factor could be maintained at a high point without correction. This situation occurred but seldom. The synchronous-motor-driven pump, that is, No. 3, was equipped with a magnetic clutch which enabled the pump to be stopped without shutting down the motor. Therefore, the motor has been kept running well-nigh continually save when the plant was closed and no water was required. The advantage of this arrangement is that a high-power factor can be maintained and that the penalization for a low-power factor, fixed by the terms of the public-service contract, can be avoided.

Fig. 1—Reclaiming thread from bobbins so that it can be used again. Fig. 2—Vacuum-cleaning system at work in the loom room removing lint from machines. Fig. 3—Some of the pretty ginghams that have made Aberfoyle fabrics famous.

When Pumps Nos. 2 and 3 were first put in place they served only the Roberts pressure filters and handled water that was free from dirt, sand, and other suspended matter. The water, however, was not soft. In 1922, the Aberfoyle Manufacturing Company realized that it would be necessary in the name of economy to install some system of filtration and water softening that would cut down the enormous bills it had to pay for soft water drawn from the city mains. Soft water is needful in certain processes where lime and magnesia would be apt to sadden the colors or harden the yarns; and because of this a contract was awarded the Permutit Company for a sedimentation and a softening plant. This

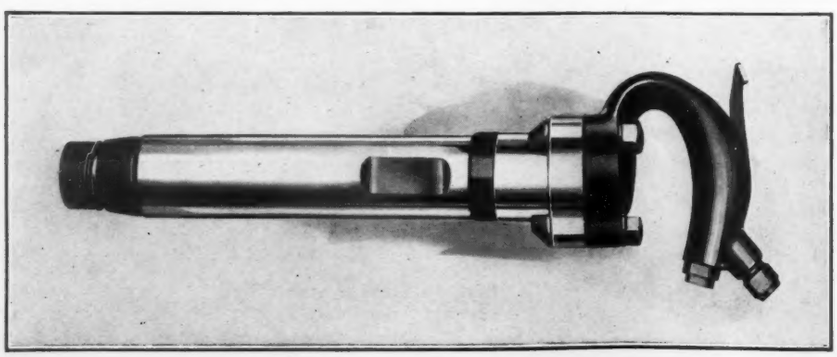


Flow sheet of water-handling and water-distributing system. In all cases water is taken first from the river through a 16-inch main which has in it, between A and B, a valve C. Valve C is generally kept closed, and is opened to allow water to reach Pumps 2 and 3 only when Pumps 4 and 5 are out of service. Water is discharged by Pump 5 directly into sedimentation tank with valves D and L closed; and it is sent from the tank through B into Pump 2 or 3, whence it goes to the softener. By closing valves F and D and opening valves K and M, water can be delivered to sedimentation tank by Pump No. 4. If the tank is out of commission, valves I, J, and M are closed. Valves F, D, K, and L are then opened and water can be taken from A through Pump 5; fed into Pump 4; discharged through the check beyond Pump 4; and sent through valve L to B—going directly into Roberts filters and on to the softeners. Valves G and H are closed the while on suctions of Pumps 2 and 3.

layout called for two pumps capable of meeting the maximum demands for some years to come; and the two 2,400-GPM pumps were purchased, accordingly. The pump driven by the synchronous motor is run when the plant is loaded and when power-factor correction is necessary, while the second unit, driven by the squirrel-cage motor, is switched in automatically for night service.

Either Pump No. 4 or Pump No. 5 can deliver directly into the near-by sedimentation tank which, in its turn, supplies water to Pumps Nos. 2 and 3; and the sedimentation tank, in its turn, boosts the pressure and puts water through the softeners or directly into the plant by by-passing the Roberts filters, as is done at present. The piping arrangement in the pump house, which holds Pumps Nos. 4 and 5, is such that it is possible to by-pass the sedimentation tank and to put water directly into the Roberts filters and thence into the softeners—thus duplicating the result obtained by means of the tank and the softener, but without the Roberts filters. This alternative distribution is controlled by valves, and the arrangement is shown diagrammatically on the flow sheet. The layout is such that the likelihood of the plant being crippled for lack of water is reduced to a minimum.

To return to the human-interest side of our subject, let us say that there are 2,000 people employed in the plant and that 90 per cent. of them are skilled operators. More than half of the personnel are women. Much as we should like to do it, if space were available, we cannot dwell upon the welfare service which affects both the working hours and the leisure of the force. Cheerfulness, coöperation, and interest in the work are manifested everywhere throughout the establishment; and this atmosphere explains why the company has a long list of applicants for positions.



The new hammer has made a hit with the operator.

NEW TYPE RIVETING HAMMER

A NEW TYPE of pneumatic riveting hammer, with many improvements and added features that make for economy of operation, has been developed by the Ingersoll-Rand Company. This tool has been thoroughly tested on all classes of work, and is now being offered only after having proved entirely satisfactory under all service conditions. The outstanding features of this new riveter are: bolted construction that makes certain of holding the handle to the barrel; a centralized, heavy section valve with liberal bearing surfaces; combination poppet and piston-type throttle valve; power in excess of all ordinary requirements; low air consumption; and exceptionally easy operation.

The new hammer is manufactured in three styles: A, or clip type; B, or bridge type; and C, or safety-set retainer type, and all of these come in a complete range of sizes from a 5-inch to a 9-inch stroke. Each riveter can be fitted with any one of three kinds of barrels and with either an inside or an outside trigger handle.

Three alloy steel bolts of substantial size, fitted with lock washers, hold the handle to the barrel. This is an exclusive feature of Ingersoll-Rand hammers, and enables them to be taken apart anywhere for inspection or cleaning with the aid of only a wrench—no vise, crowbar, or other tools being necessary.

The valve is a sturdy sleeve, made of special alloy steel, whose walls are free from holes or ports which so often are the starting points for checks or cracks. It operates in a valve box, of strong construction, located in the head of the barrel. The valve box has a solid end, and this makes it possible, by the use of a piston, to readily take the box apart for the removal of the valve. This construction also insures a compression chamber in the valve box that cushions the piston on the return stroke and prevents the piston from striking the handle.

Though this improved type of pneumatic hammer is hard hitting, still less "kick-back" than usual is felt with it; and it does not consume as much air as older tools of this kind. Furthermore, as the new hammers are lighter in the handle end by reason of the bolted construction, they are better balanced and easier to hold, especially when used in a horizontal or inverted position.

Putting Palm Beach in Touch With the World

By VERNON H. VANDIVER

THE particular section of the State of Florida known as the sub-tropical zone—embracing Palm Beach as its principal point of contact with the outer world—has, during the past two decades, undergone such intense agricultural development and, at the same time, become so popular as a winter resort, that of late years it has become economically imperative that its harbor, Lake Worth, be opened to deep water transportation to foreign and eastern ports. With Lake Worth open to seagoing craft, Palm Beach, it is said, will be made more accessible to ships from New York than Jacksonville now is—thus giving the farmers and fruit growers of the region a distinct advantage in disposing of their produce to the great markets of the world.

Before outlining the work that must be done, it might be well to describe the peculiar formation of the eastern coast of Florida. Along the whole length of that seaboard stretches a line of sand reefs and narrow islands, enclosing shallow and narrow bodies of water. Of these, Lake Worth is the most suitable for a harbor. Here, however, Nature apparently decided that the garden spot she had created, with its temperature moderated by cooling trade winds and with a harbor already made, would not be properly appreciated by her sons. Hence, she very nearly enclosed Lake Worth with a bar of as hard rock as can be found in Florida, leaving an inlet with a depth of but seven feet. The current through this inlet runs from five to eight miles an hour with only about ten minutes of slack tide.

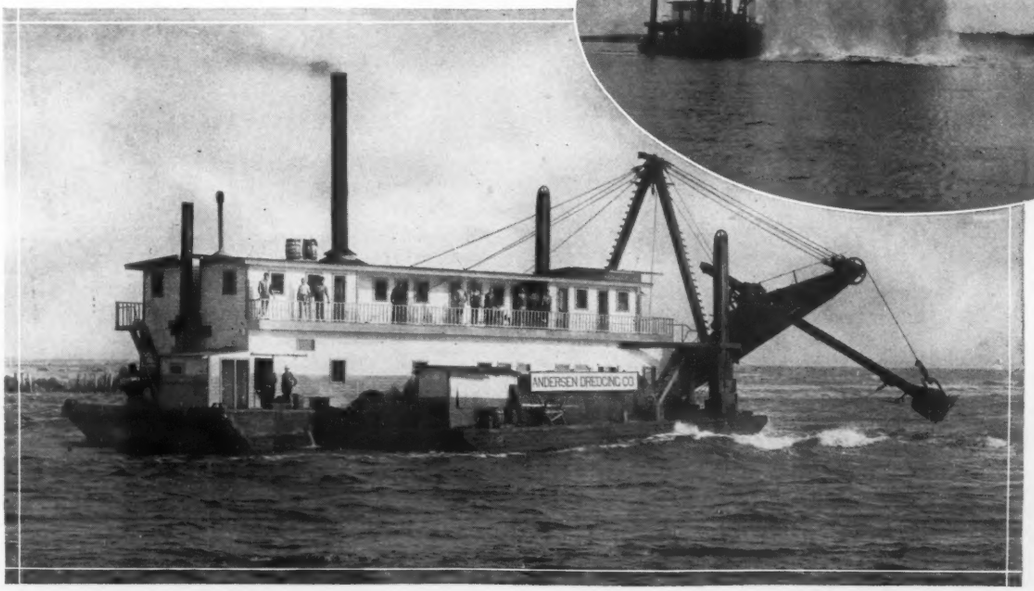
To remove this natural obstacle, the Lake Worth Inlet Commission was appointed. For four years this commission advertised for bids on deepening the inlet, but without receiving a satisfactory proposal. Finally, however, the Andersen Dredging Company of West Palm Beach—composed of local business men with Mr. A. S. Andersen as president and general manager — devised a plan that was acceptable and submitted a proposition that enabled the commission to undertake the project.

Looking forward on the "Hercules," showing the tracks for the drill-frame carriage and the flexible steam-hose connections.

In November, 1921, a contract was made between the commission and the dredging company under which the latter agreed to build all the necessary equipment for the removal of the rock and to cut the desired channel for the nominal consideration of but $5 per cubic yard of rock. Considering the hardness of the rock and the fast current in which the work would have to be carried on, most contractors predicted failure at this price. Some of the other bids ran as high as $23 per cubic yard; but the Andersen Company has fully demonstrated its ability to make a profit at the price quoted.

The first step towards carrying out this difficult engineering task was the building of the drill boat *Hercules*. The *Hercules*, which differs in some respects from the usual type, was designed and built by Mr. Andersen. This craft is 70 feet long and has a beam of 24 feet. The depth of its hull is but 6 feet. Massive spuds, 20 inches square and 44 feet long, are provided to raise the hull to the proper height for drilling and to hold it in the swift current.

Owing to variations in the rock formation, it was necessary to vary the spacing of the holes, and as this could not be done with stationary drill frames, the drill frames on the *Hercules* were placed on a carriage and track which permit them to be moved along the side of the boat so that any desired spacing can be secured. The frames are of such a height that holes can be drilled to a depth of 30 feet below the surface.



The dredge "Edmond S. Fowler," which had to be especially built for top loading the rock on account of the shallow water. Oval—Setting off a blast of nine holes charged with dynamite.

The drilling equipment consists of a battery of three 4¼-inch steam drills with slab-back mountings and flexible steam-hose couplings. These drills have a piston stroke of 8 inches, and deliver approximately 400 cutting blows per minute. With but 75 pounds of steam pressure at the throttle they will easily drill holes of from three inches to six inches in diameter to a depth of 27 feet.

The drill steels are fastened to the pistons by means of U-bolt chucks and are turned after every stroke by the aid of Sergeant rotative elements, which are distinctive features of Ingersoll-Rand drills. Nine holes, 3½ inches in diameter and from 4 to 5 feet deep, are drilled at one setting. These holes are spaced 5x6 feet apart and are loaded with about 30 pounds of 60 per cent. dynamite. The charge is set off with waterproof, electric blasting caps.

The *Hercules* was finished in June, 1922; and the drilling was started while the dredge, *Edmond S. Fowler*, was under construction. But with the completion of the dredge, which was designed by the Marion Steam Shovel Company and built by Mr. Andersen, the work was started in earnest. The dredge is equipped to make 25 feet of water, and has a 1½-yard dipper.

On account of the shallow water across the bar it was found impossible to dispose of the rock in bottom-dump barges with tugs. The Andersen Company designed and built a barge with a top dump and a capacity of 25 yards. This was equipped with an internal combustion engine and a double-drum hoist so that it could heave itself to a point in line with the jetties—the excavated rock being used for jetty foundation. However, now that the work is approaching completion, this has been replaced by bottom-dump barges.

The first contract called for 20,000 yards. The cut is 150 feet wide, and the distance through the outer reef is 750 feet. When the contract is completed, the inlet to Lake Worth will be 12 feet deep; and then money will be made available for the continuation of the excavating to a depth of 18 feet. The latter task will involve 32,000 yards additional.

Mr. Andersen, who is in active charge of the operations, has spent seventeen years in the dredging business. Practically all his experience has been in harbor work. He took an active part in improving Cuban harbors, in building terminals for the Florida East Coast Railway at Key West, and in establishing the Governmental Naval Base at the same point. Acknowledgment is made to *The Explosives Engineer* for their courtesy in supplying the photographs and some of the information contained in this article.

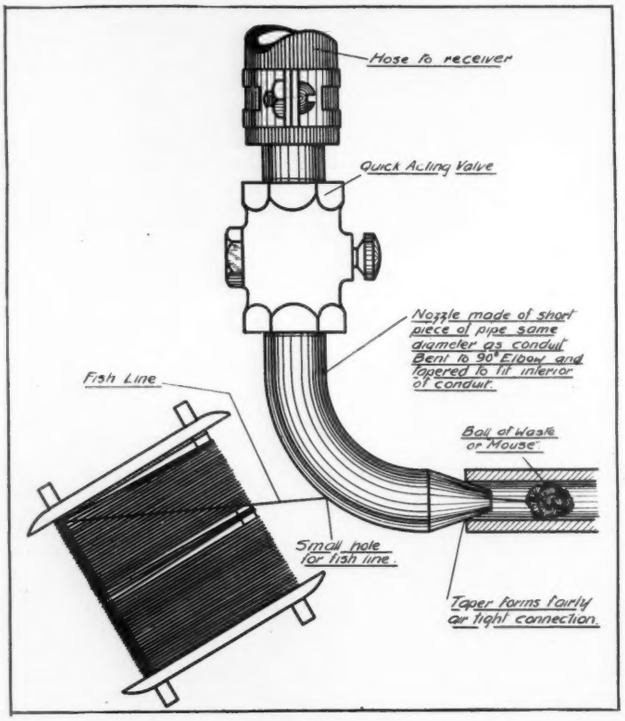
With the completion of new electric power plants now under construction in the Sila Mountains, Italy will have created a super-power system capable of distributing current from the Alps to Sicily.

The writing of life insurance is the largest single business in the United States. The aggregate sum of the policies now in force amounts to $55,000,000,000.

COMPRESSED AIR EFFECTIVE IN FISHING CONDUITS

AN INGENIOUS substitute for the present method of fishing indoor conduits by hand with a wire was recently conceived by John T. Myers while at work installing a telephone system in the new Hotel Statler, Buffalo, N. Y.

The equipment, as devised by this ingenious wireman, consists of a compressed air tank capable of withstanding a test pressure of 300 pounds and a working pressure of 150 pounds, and of a 1¼-H.P., 110-volt, heavy-duty motor belted to a 4-cylinder air pump mounted on four wheels. The pump is housed in a sheet-iron casing whose top cover is hinged. A check valve was placed between the pump and the air tank to maintain the desired pressure; and a gage was fitted to the tank to record the air pressure in pounds. As an added precautionary measure, the tank was provided with a relief or safety valve so as to prevent any over compression. About 25 feet of hose was required to convey the air to the conduits; and air at a pressure of 75 pounds was used to fish the conduits and to blow them out.


Hose to receiver
Quick Acting Valve
Nozzle made of short piece of pipe same diameter as conduit Bent to 90° Elbow and Tapered to fit interior of conduit.
Fish Line
Ball of Waste or Mouse
Small hole for fish line
Taper forms fairly air tight connection

Features of pneumatic apparatus devised for "fishing" or clearing conduits.

With this outfit, each conduit was first blown out until it was clean and clear of obstructions. Then the fish line was fed through a small hole in the outer and lower side of a 90-degree nozzle. This elbow-shaped nozzle is of the same diameter as the conduit but slightly tapered at the outlet so as to enable it to project into the pipe to facilitate running the fish line through. Next, a suitable piece of waste material, or a "mouse," was fastened onto the fish line and inserted in the conduit. By means of a lever valve, located back of the nozzle, air was released, and this forced the mouse with its attached fish line through the conduit. This done, the wires were readily pulled through the conduits by means of the fish line. The latter was used over and over again, but the mouse was replaced as often as necessary.

This method proved so successful that two men could clean and fish an entire floor, consisting of 97 rooms, in two days. The cost of the material for the blower equipment was less than $50 plus one man's time for one week. The blower was also used for cleaning out motors, generators, etc.

PROPOSED MENAI STRAIT DAM-BRIDGE

MENAI Strait separates the mainland of Wales from its projecting northwestern county, the Island of Anglesey. The Menai Strait suspension bridge—opened to traffic in 1826, very nearly a century ago, was for many years a world wonder. From an engineering viewpoint it is now of little account—being but 600 feet between piers and not permitting very heavy traffic. It happens that the bridge, grown old, shows its age—as is the habit of things; and it has been seriously contemplated to replace it with a modern and more capacious structure. Latterly, however, a new scheme has been proposed in connection with it that cannot fail to attract attention.

A powerful tide, with a very rapid rise of more than twenty feet, races through the strait. It is recognized that here, perhaps, is the most inviting place in the world for an experimental demonstration of the utilization of tidal power. It is planned, therefore, to construct a dam near the bridge with all the features necessary to develop and to employ the power going to waste. It is furthermore proposed to carry pillars or arches up from the dam to support a bridge immediately above it. The structure, as a whole, would thus comprise either a bridge-dam or a dam-bridge, as the people might choose to call it.

WIRELESS ON RAILWAY CARS

EXPERIMENTS have been made recently on the Great Western Railway, England, to test the possibilities of wireless transmission on high-speed trains. A 6-valve receiving set was placed in a brake van on the 4.10 London to Birmingham express; and speech and music from the London station were successfully picked up all the way to Birmingham. When the train was traveling at a speed of 80 miles an hour and was 40 miles out, loud-speaker reception was extremely good—the volume being sufficient to enable the music to be audible in spite of the noise of the train. At 60 miles from London the set was tuned to the wave length of the Birmingham station, and the transmissions from there were likewise heard distinctly. The tests were continued on a returning train with results equally satisfactory.

Compressed Air Helping to Build Sewer in Christiania

Section of completed sewer showing brick lining.

Inside the air lock during work of excavating.

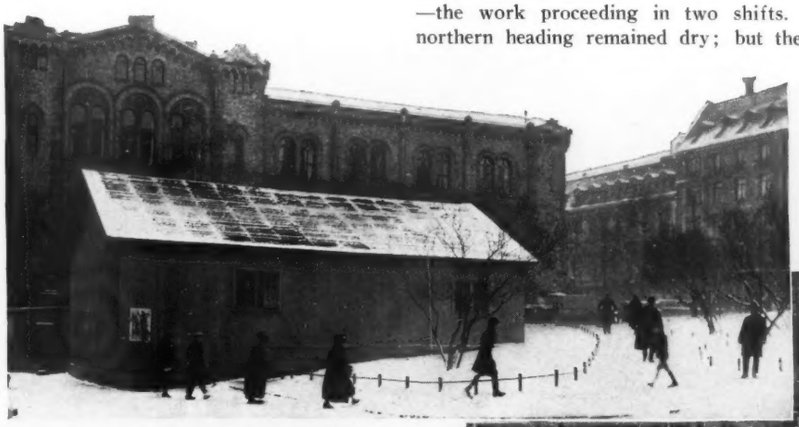
Rock surfaces were gunited before lining with brick.

ENGINEERING circles in the City of Christiania, Norway, as well as the general public, are at present very much interested in a project of considerable magnitude now being carried forward under the direction of the municipal authorities. The undertaking involves the construction of an extensive trunk-sewer system through the heart of the capital. In addition to the usual difficulties incident to underground excavating where streets are narrow and traffic is heavy, ground water has been encountered in sufficient quantities to make the employment of air locks necessary in certain sections of the line. It is believed that this is the first time in the history of the Kingdom of Norway that tunneling has been done under air pressure; and it is very much to the credit of the engineering staff in charge that the work is proceeding so quietly and efficiently that the populace has suffered little if any inconvenience.

The tunnel has a diameter of 6½ feet; and much of the section that is being driven through rock lies about 36 feet below street level. The rock encountered consists primarily of shale interspersed with porous strata, and this—aside from the depth at which the tunnel is run—has made it necessary to carry on the work under pressure. Every precaution is being taken to prevent the settling of the foundations of buildings along the line of progress. In the outskirts of the city, the sewer takes the form of an open culvert.

Operations were begun in November of 1922—the work proceeding in two shifts. The northern heading remained dry; but the men going in the opposite direction encountered water after they had advanced about 328 feet. Compressed air locks were promptly installed. These locks, which have been satisfactory in every respect, are 15¾ feet long; have an internal diameter of 6 feet; and were designed for a working pressure of about one atmosphere which, roughly speaking, is equivalent to the pressure of a 33-foot column of water. This was found to be more than was needed; so the pressure was reduced to that corresponding to a column 23 feet high. Subsequently, the pressure was raised to that of a 26½-foot column of water, at which point it has since been held. The air required amounts to about 70.6 cubic feet per minute, and is provided from a centrally located compressor plant temporarily erected for the purpose.

This plant, shown in one of our accompanying illustrations, contains three compressors: a 9x8-inch machine, which supplies air at a



Temporary compressor plant erected at rear of House of Parliament.

First pneumatic paving breaker in Norway cutting into frozen ground in excavating for the new Christiania sewer.

working pressure of 100 pounds for the "Jackhamers" and stopers used in driving the tunnel through the rock, and two Type ER-1, low pressure units, a 12x8-inch and a 12x10-inch, each capable of furnishing air at a pressure of 35 pounds. One of these provides the air necessary to keep the ground water at bay in the workings and to operate the locks: the other is a reserve machine.

Blasting underground is done electrically, and to this end special ignition lines are led up through the shafts to the surface, from which point the actual firing is controlled. As Christiania is at the present time carrying on extensive harbor improvements, the earth and rock excavated are being used for making fills in connection with this work.

With the tunneling completed, the next step is the lining of the sewer. As the rock through which much of the system runs is pervious to water, the problem has been to give the walls a thoroughly waterproof coating. The lining, as finally decided upon, promises to be satisfactory in every respect. After all loose stones have been removed, the walls are first given a covering of gunite. This is placed by means of a cement gun drawing its needful operative air from the 9x8-inch compressor. Next is applied a waterproof compound made up of asphalt dissolved in turpentine. Many asphalt mixtures were tried out before a suitable one was finally discovered.

After these preliminaries—and as soon as the waterproof layer is dry—split, circular iron forms, having an inside diameter of about 6 feet, are put in position for the placing of concrete. This does not finish the lining of the tunnel, however, as might well be imagined. As may be seen in one of the accompanying illustrations, the exposed layer consists of hard-burned brick laid in cement grout. When entirely completed, the sewer has an internal diameter of 5¼ feet. It might not be out of place here to mention that the tunnel is built in sections, that is, a stretch of approximately 345 feet is drilled, blasted, and lined before the entire equipment is moved forward to start operations all over again.

All the compressed air equipment on this job, including the cement guns, is of American make and was supplied by K. Lund & Company, of Christiania, Norway, to whom we are indebted for much of the information contained in this article.

AUTOMATIC IGNITION

A CURIOUS and hitherto unrecognized danger in connection with the handling of gasoline and other highly volatile derivatives is the power which they have of generating static electricity. Attention is called to this in a recent issue of *Nature*. Ignition of volatile oils through static discharge has been known to occur in barber shops, in garages where men have chanced to wipe their hands with silk rags soaked in gasoline, in filling tanks of motor cars and using a piece of chamois for filtering, etc.

A still more curious case is that of the chauffeur who was drawing oil from a self-measuring tank into a can with a wooden handle. He hung the can by this handle, insulating the receptacle, and thus the oil caught fire on two successive occasions.

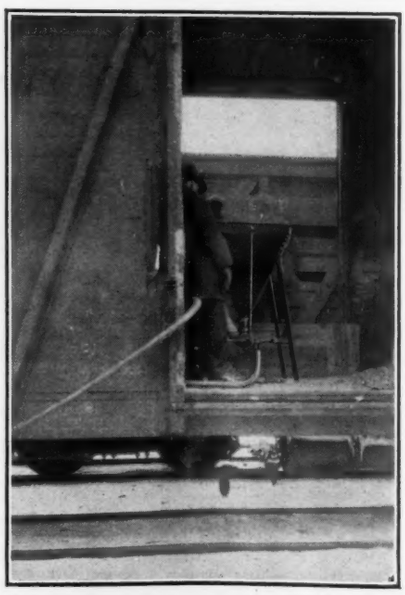
PNEUMATIC FEEDING OF LIVE STOCK IN TRANSIT

FEEDING live stock by the aid of compressed air is one of the latest developments in speeding up the transportation to market of these domestic animals. Whenever it is necessary to feed a trainload of live stock, an engine with a grain car coupled to it is run

Pneumatic live-stock feeder.

alongside. In the grain car is a feeder—a metal hopper held at a convenient height by legs. An air line from the engine is led to this hopper, and the compressed air so supplied drives the corn or other grain through a feed hose successively into each of the cattle cars.

With this outfit, feed can be furnished to double-deck cars at the rate of ten bushels every two minutes; and grain can also be transferred in this way from "bad-order" cars at a decided saving over the ordinary methods. The Chicago, Milwaukee & St. Paul Railroad is putting in these feeders between the Dakotas and the Pacific coast.



Compressed air speeds up the feeding of hogs and other live stock in transit.

DODDER DEFEATED

DODDER is a parasitic weed that twines around the stalks of respectable plants and gets its living from them. It often becomes so widespread as to cause serious inconvenience as well as considerable loss to the farmer. In clover, especially, its eradication has presented a most serious problem. Seeds of the two plants become mixed; and, being quite small and similar in size, it has hitherto been impossible to throw out the intruder. Nevertheless, the trick is now being done, and one would never guess how. When we say that an electro-magnet does it, the mystery only deepens; but the explanation is very simple.

A quantity of very fine iron filings is sifted upon and stirred into the mixture to be separated, and the mass is moistened. The wet clover seed remains smooth and clean, but the dodder develops a sticky substance to which the iron dust clings. Then the seed is poured in a thin, flat stream in front of a powerful electro-magnet without actually coming in contact with it. But even so the pull of the magnet is sufficient to draw the iron-coated seeds slightly out of their vertical course and away from the clean clover seeds, so that the latter drop straight down while the former are carried a little to one side and deposited in a separate receptacle—and there you are.

PERFECTING LAUGHING-GAS EXPLOSIVES

A SERIOUS objection to the employment of ammonium-nitrate "safety" explosives in mining has been the readiness with which they absorb moisture. A British firm seems to have reached a solution of the problem involved in a so-called "Barwick Powder," a powerful ammonium-nitrate explosive, in granular form, that can be used in cartons or poured directly into drill holes. It contains no nitroglycerine, but equals gelignite in strength; and it is now being employed extensively in metalliferous mines, in quarries, and in many collieries where gelignite was previously utilized. Its resistance to water has been thoroughly tested. It is also claimed that the gases generated on explosion are not poisonous; that the powder does not freeze; and that it is insensitive to concussion.

SPEEDING UP THE DRYING OF BALL GROUNDS

TURNING away a big crowd on account of the temporarily bad condition of ball grounds, is a costly experience for managers. With this fact in mind, the study of drainage and soil problems was included in the investigations preliminary to the building last year of the football stadium for the University of California. The results were highly satisfactory. *Engineering News* tells us that by using more or less impervious earth to fill in a former creek bed; by packing that fill to establish a new and permanent water table and overspreading that with pervious earth topped with special grasses; and by installing tile drains, the water was carried off so quickly that a game could be played on the field that had become comparatively dry within an hour after the worst 24-hour downpour ever recorded.

Constructing A Difficult Subway With Consummate Skill

Work on Queensboro Subway Extension in New York City Going Steadily Forward

By A. S. TAYLOR

WINNING out against odds in a geological gamble. This, in substance, sums up much of the work involved in the construction of the Queensboro Subway Extension in the Borough of Manhattan of Greater New York.

As has been previously explained in the Magazine, the purpose of this connecting link is to lessen congestion and to facilitate the easy exchange of passengers between the present terminal of the Queensboro subway and the Broadway and the Seventh Avenue subway lines nearly three-quarters of a mile away to the westward. Today, to reach the union station of the Broadway and the Seventh Avenue subways from east 42nd Street, a subway shuttle runs back and forth beneath 42nd Street for this service and daily transports fully 100,000 persons. It is authoritatively estimated that more than 25,000 of these are passengers bound to and from the Queensboro terminal.

Strange as it may seem, exploratory borings were not made along the route chosen for the extension, and the only explanation for this omission probably lies in the general knowledge developed of the underlying rock during the excavating for the foundations of the towering buildings adjacent to the line and when digging that section of the original subway system which traverses 42nd Street from Park Avenue westward to Times Square. Nature, however, is by no means consistent, and the matter of a comparatively short distance or even a few feet may make a marked difference in the geological formation hidden away below the ground's surface. This has certainly been the case along the line traced in drilling and blasting the tunnels and open cuts for this new transportation link. The rock encountered has ranged all the way from extremely hard schist to an unstable type of rock so soft that every foot of advance has called for heavy timbering and very careful work to guard against possible collapse. Not only that, but it has been necessary that the contractor be continually on the alert lest some of his operations endanger the structures standing above and along each side of the greater part of his line of progress. These details are mentioned in order that the reader may be the better able to appreciate what has been done since work was begun in 1922.

For the sake of those unfamiliar with this momentous engineering undertaking, let it be said that the Queensboro extension has a total length of 3,660 feet. Starting at the end of the old Steinway tunnel near Park Avenue and 42nd Street, the route runs westward across Fifth Avenue and into Bryant Park, where it swings to the south and west for a block to Sixth Avenue and 41st Street. From that point onward, the project is carried beneath 41st Street until it comes to a halt under Eighth Avenue. Before reaching the Eighth Avenue terminal, the extension will underrun the existing Broadway and Seventh Avenue subways; and one of the most difficult parts of the task will be to support these subways

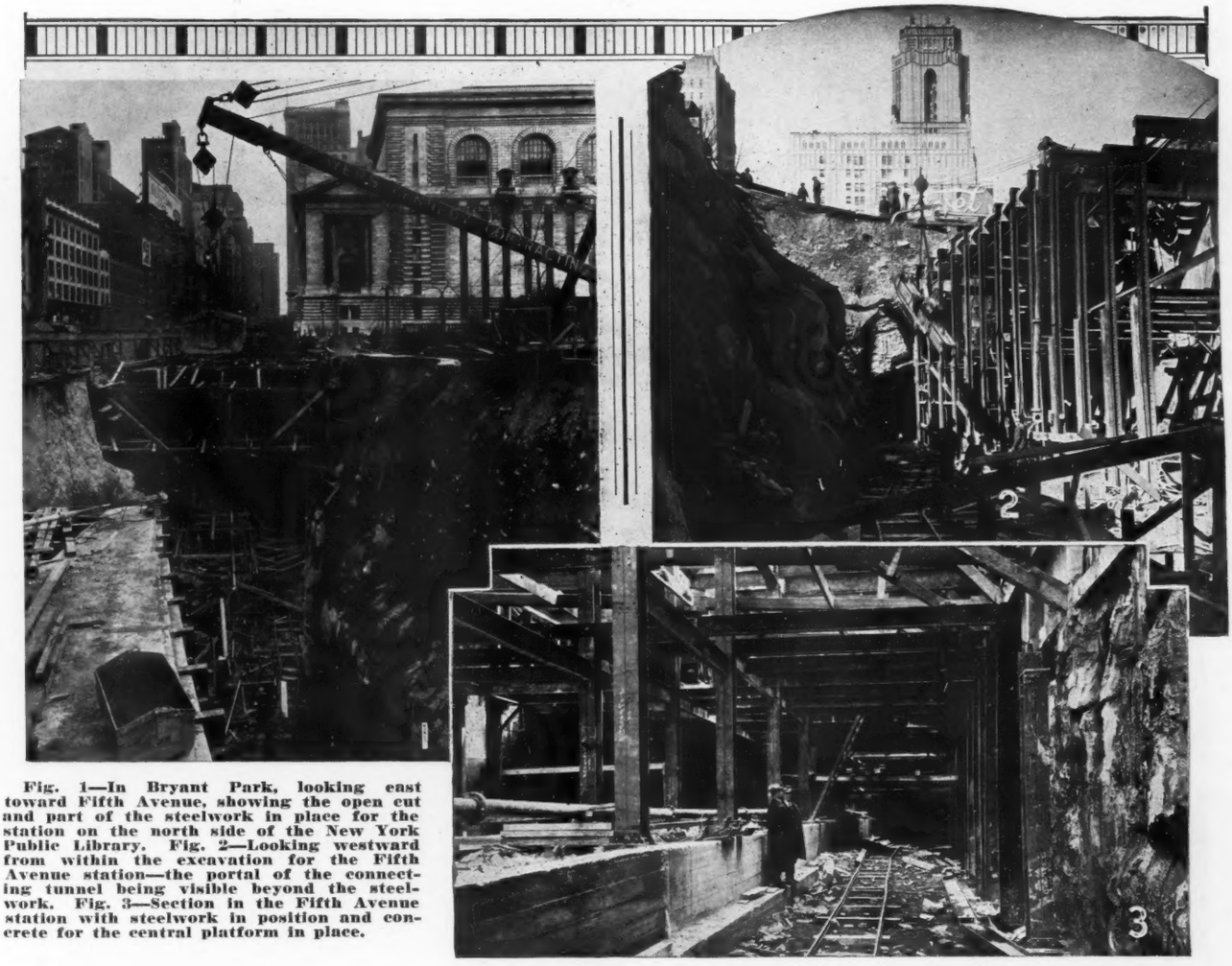


Fig. 1—In Bryant Park, looking east toward Fifth Avenue, showing the open cut and part of the steelwork in place for the station on the north side of the New York Public Library. Fig. 2—Looking westward from within the excavation for the Fifth Avenue station—the portal of the connecting tunnel being visible beyond the steelwork. Fig. 3—Section in the Fifth Avenue station with steelwork in position and concrete for the central platform in place.

while removing a great mass of interposed rock so that the three lines may be joined by a common station.

Last August, the Magazine covered in some detail the essential features of the project and described the manner in which certain engineering hazards incidental to the work had been successfully disposed of. As may be recalled, the entire job involved five of these so-called "major hazards," and three of them had been safely left behind at that time. Those passed were: tunneling close beneath a big 6-foot sewer; driving twin tunnels under the existing busy subway loop below 42nd Street; and underpinning the entire northern foundation of the New York Public Library—a building that cost when finished in 1911 quite $9,000.000. The remaining hazards, not yet attacked, are the underpinning of both the Seventh Avenue and the Broadway subways and the linking of the three lines at that point.

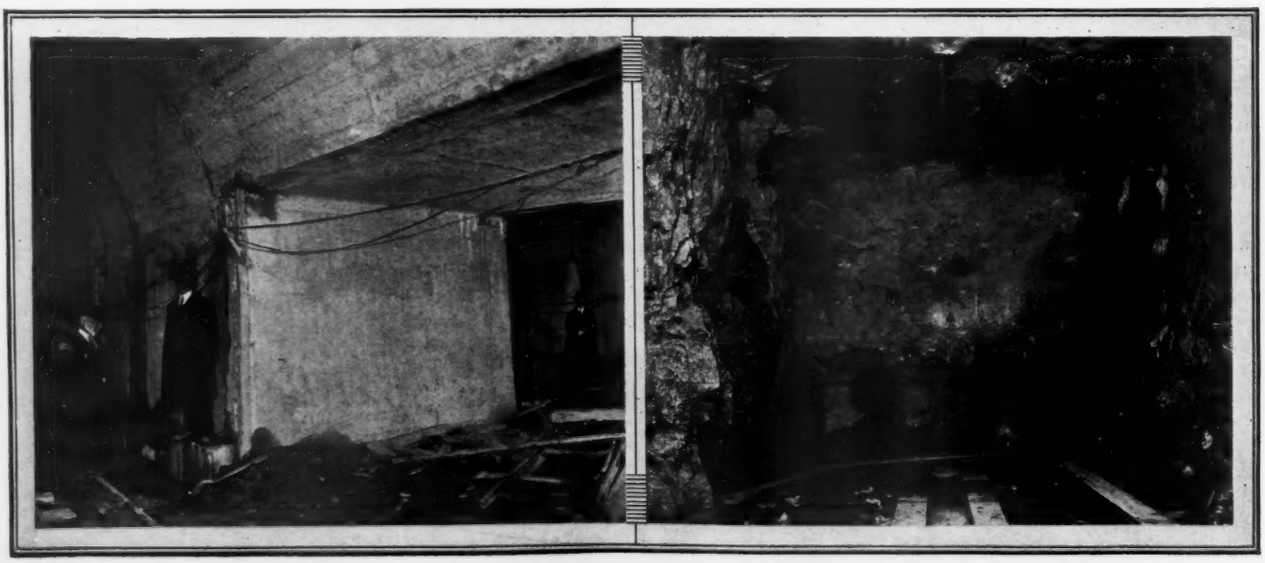
Close-up of the underpinning placed beneath the New Amsterdam Theater. So well has all this work been done along the route of the tunnel that there has been no evidence of subsidence in the walls of any adjacent buildings.

It should not be inferred that the foregoing hazards were the only difficulties confronting the contractor. His task has bristled with them at well-nigh every stage of his advance; and to the casual citizen a goodly number of these difficulties would also seem to justify the designation of "major hazards." For instance, in driving the twin-track tunnel which traverses the rock under Fifth Avenue, drilling and blasting was done beneath four lines of 48-inch water pipes, and it was essential that this work should be done so carefully that the explosions would not wrack and rupture those fully charged conduits. One does not have to have a vivid imagination to realize what would have happened had those water lines been converted suddenly into spouting geysers!

This possible menace to traffic and to property was sidestepped by driving a pioneer tunnel well below the four mains. The tunnel was eight feet high and nine feet wide; and with this passage cut it was practicable to enlarge the tunnel progressively and to drop the overhead rock by drilling numerous holes and by using in each of them a small charge of 60-per cent. dynamite. Thus, step by step, the intervening rock was cleared away without setting up injurious concussions. Ultimately, there was left a ceiling of rock about ten feet thick vertically between the underside of the pipes and the crown of the tunnel.

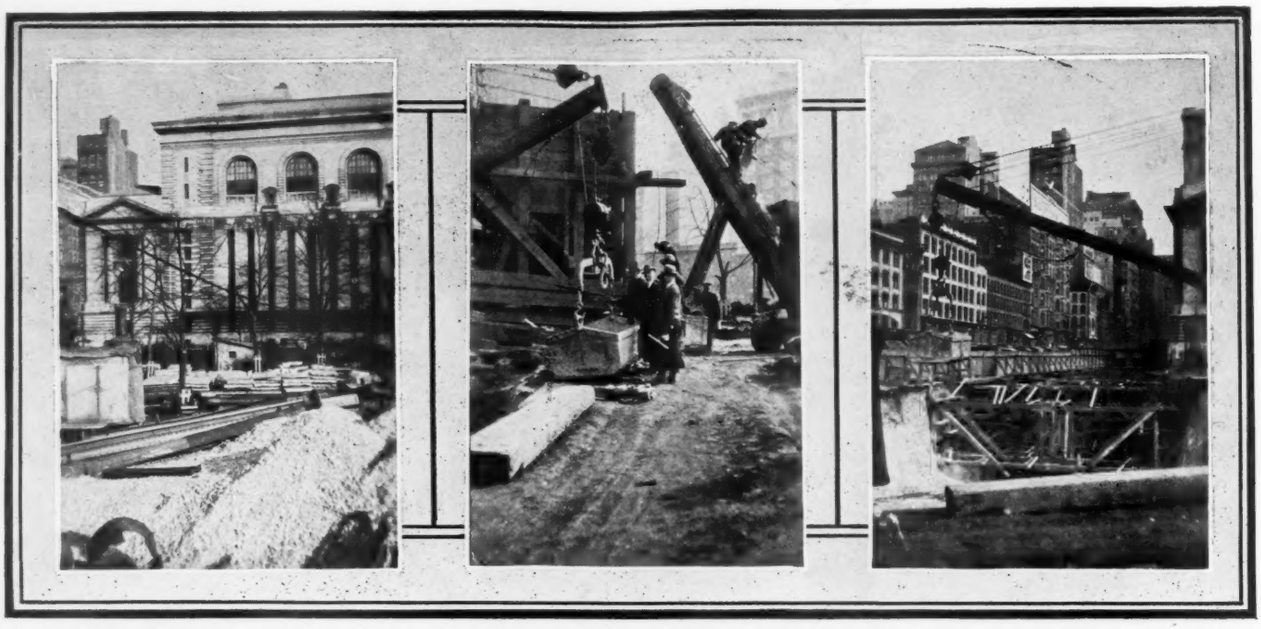
On the western side of Bryant Park a shaft reaches from the surface down to the aqueduct tunnel. The tunnel and the shaft form part of the Catskill Water Supply System and are filled with water under high pressure. The twin-track tunnel of that section of the Queensboro Subway Extension which runs from the Fifth Avenue station in Bryant Park westward to 41st Street pierces the rock near the aqueduct's shaft. That is to say, from the center line of the tunnel to the center line of the shaft there is an interval of 50 feet, while from the outside of the tunnel to the outside of the adjacent shaft the separating mass of rock is not more than 30 feet through. Again, the contractor was face to face with a decidedly ticklish problem. Ordinarily, in advancing his heading, he would have drilled from 26 to 28 holes for a round and used enough dynamite to shatter the rock penetrated by these relatively few holes. This course was prohibited because of the proximity of the aqueduct shaft.

Instead of 28 holes, for instance, "Leyner" drills were used to drill 126 holes, and most of these were driven around the crown and down the side of the heading nearer the shaft. In fact, the procedure amounted almost to channeling, so that only small charges of dynamite were needed to break away the rock. If by any chance the shock of blasting had been severe enough to weaken the enveloping wall of the shaft, a tremendous flood of water might have been let loose to deluge the neighboring district and to undermine hundreds of tall structures standing between the outpourings of that subterranean torrent and the Hudson River. We are committing no breach of



Left—Cross-over section of the Queensboro Subway Extension at the start or eastern end of the undertaking. Right—Westernmost limit of the job—the terminal on 41st Street below Eighth Avenue.

Fig. 1—"Jackhamers" drilling blast holes in widening out tunnel at umbrella section under 41st Street. Fig. 2—Dressing bench with "Jackhamers" in the north tunnel at the west end of Fifth Avenue station. Fig. 3—"Leyner" drills at work on side wall of tunnel midway between Seventh and Eighth Avenues. Fig. 4—Another view of the drilling operations in the tunnel under 41st Street. Fig. 5—Trimming the bench in the pioneer tunnel under Bryant Park. Fig. 6—Again the ever-useful "Jackhamer" at work in south tunnel at Seventh Avenue station.



In Bryant Park, adjacent to the New York Public Library, where are centered the activities in connection with the Queensboro Subway Extension.

confidence in saying that some of the city's engineering experts were apprehensive until the tunnel had been pushed well beyond the water-system shaft. From a layman's point of view, the passing of that aqueduct connection might well have been classed among the major hazards.

Since our previous article, the Powers-Kennedy Contracting Corporation has gone steadily onward; and during a period of 21 months has completed 90 per cent. of all earth excavating, 46 per cent. of all rock excavating other than that having to do specifically with tunnel driving, and 44 per cent. of tunnel excavating. Expressed otherwise, these three most difficult phases of the undertaking have at the present time reached stages which in the aggregate represent the accomplishment of fully 50 per cent. of the entire task. This is unquestionably a remarkably fine showing, and one that becomes more impressive when the physical conditions encountered are taken into consideration. The magnitude and the exact character of a number of these could not be foreseen.

In excavating the open cut traversing much of Bryant Park, the contractor was called upon to carry his northern line for some distance right against the southern wall of the present subway shuttle, running beneath 42nd Street, and also to carry his southern line directly beneath the foundation of the north wing of the New York Public Library. In short, he was obliged to excavate every inch of the intervening rock and earth lying between these two structures. This meant, of course, that some special provision should be made for bracing and sustaining the wall of the subway and the foundation of the library while carrying the open cut down to its prescribed maximum depth, that is, 42 feet below the street level. It was impracticable to resort to the usual system of timbering, because supports of that kind would have interfered with the necessarily close work called for along the flanking walls. Further, the contractor planned to utilize a steam shovel for mucking—an innovation in underground operations of this sort.

To meet this exacting situation, the contractor introduced heavy trusses of sufficient length to span the whole width of the excavation. These trusses rested upon rock at their

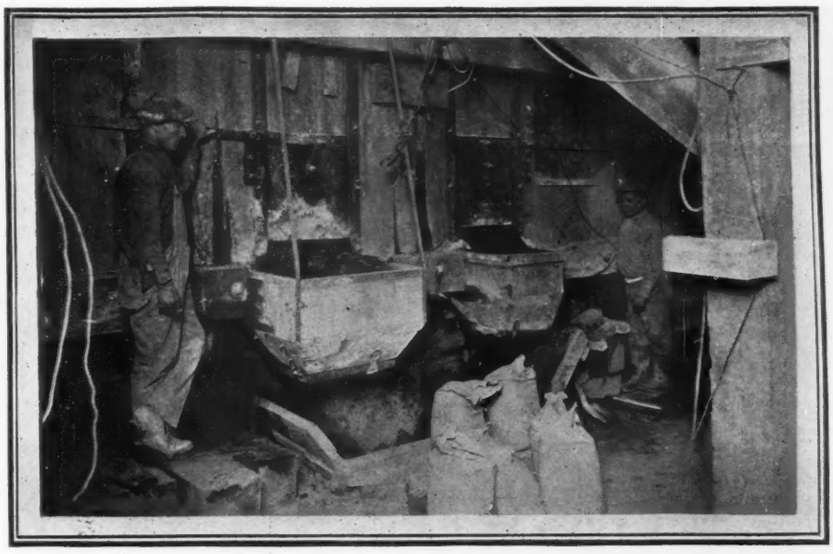
Circle—Heading being pushed westward from shaft at Sixth Avenue and 41st Street. Left—Rock tunnel running into rather soft ground under Bryant Park.

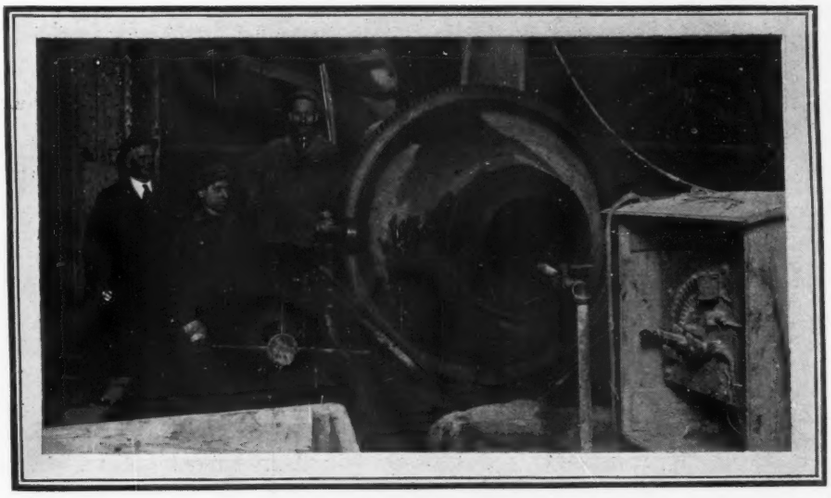
southern ends while their north ends reposed upon the exposed wall of the existing 42nd Street subway. By this ingenious arrangement, the contractor had the full width of his cut in which to work freely, and at no point were there any posts to obstruct the drillers and others engaged in mucking, etc. Similarly, the steam shovel was able to do its part unhampered and to aid to a marked degree in speeding up the removal of spoils. In underpinning the foundation of the library which, strange to say, had not been carried down to solid rock by its builders, the contractor was obliged to interpose concrete supports—some of which were 24 feet high—in order to tie the foundation footings to the underlying ledge.

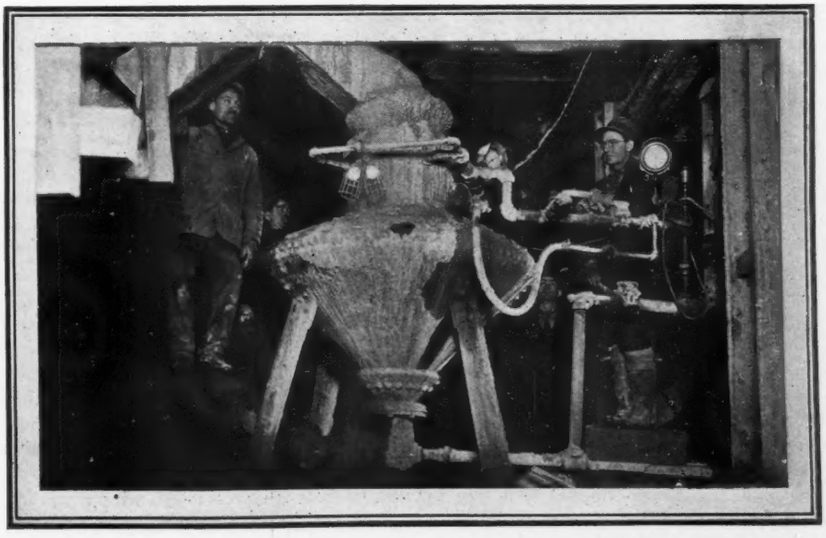
The underpinning of the library—though extensive and calling for the exercise of great care—was a relatively simple problem compared with that of providing ample support for the much taller and heavier buildings standing on both sides of 41st Street along the route of the Queensboro Subway Extension. Not only do the walls of these structures in many cases flank the north and the south limits of the subway excavation, but at points the cellars or vaults of these buildings extend out under the sidewalks and actually project into the excavation. Not infrequently, there are coal bunkers and boiler rooms in these vaults; and it has been necessary to leave these projections undisturbed because they were essential to the operation of the associate structures. As can be easily understood, the contractor has had to display much resourcefulness in supporting the varying overloads all along this part of the line; and so successfully has this been done that there has been no settlement of the street surface or subsidence or cracking of pavements and building walls. Let us explain how this essential precautionary work has been done, the importance of which is made apparent by some of our illustrations that show the character and the towering masses of a number of the near-by business edifices.

In excavating the rock on 41st Street west of Seventh Avenue, for instance, where will be located the Seventh Avenue station of the new line, the contractor has avoided the use of temporary vertical supports by adopting heavy steel I-beams and girders which rest at either end upon solid rock. These girders, in their turn, support both the decking and all sheeting and shoring required to steady or sustain the excavation. One of the notable features of this part of the work has been the general absence of wedges, which are always a bugbear and a source of heavy expense. Wedges have been rendered unnecessary by cutting all timbering to exact lengths; and the employment of steel I-beams and girders has made this practicable. Further, the contractor has made little if any use of spikes in erecting his timbering. He has relied upon bolts and nuts instead—the holes for these fastenings being bored by pneumatic augers. This procedure has saved time, has obviated the driving of spikes, and has resulted in a much better and stronger job.

As the excavation has proceeded downward, the girders have carried all the incidental loads until points have been reached where the per-







Here we have the sequence of operations in the pneumatic placing of concrete. The aggregate, sand, and cement, in proper proportions, are fed by a chute to the underlying mixer where water is added, and from the mixer the concrete falls by gravity into the "shooter" from which it is blown through a 6-inch pipe to the point of placing. Concrete has been conveyed in this way a distance of 1,160 feet, rising 67 feet during the run and passing through nine 90-degree turns in the line.

manent steelwork of the subway could be put in place for the station structure. With this done, the various stresses and pressures exerted from outside the excavation have been transferred to the permanent steel fabric. By this system, the contractor has avoided the inconvenience and the labor otherwise incident to removing or replacing braces, struts, and kindred temporary aids to his work, and he has thus been able to carry on all of his operations within an unobstructed space.

Until recently, the Powers-Kennedy Contracting Corporation has been hampered by the fact that operations could be carried on from openings at only three points, and this has correspondingly limited the number of headings at which drilling could be done. From now on, however, the situation will favor a greater number of points of attack, and progress will be speeded up proportionately. In driving the tunnel westward from Bryant Park toward Sixth Avenue and 41st Street, rock has been encountered of such a soft and disintegrated nature that heavy timbering has been required every foot of the way. Indeed, the procedure has called for the driving of pilot tunnels which have necessitated the placing of posts and caps of 12x12-inch timber and the laying of wall plates of 16x16-inch timber. Then followed the gradual and laborious widening of the tunnels and the deepening of the benches—work in which "Leyner" drills and "Jackhamers" have played an indispensable and conspicuous part. As might be expected, progress in such circumstances has entailed the drilling of four or five times as many holes and the use of much more dynamite than would have been the case had the contractor been free to drive a normal-sized heading, then to blow down the rock above, and thereafter to widen out without fear of collapse.

On March 13, the contractor holed through just west of the Fifth Avenue station when the eastbound and the westbound heading of that tunnel section met under Sixth Avenue. As a result of that meeting, a way has been opened which runs continuously from the easternmost end of the project to Broadway. Further, the work of tunneling westward from the shaft in 41st Street, just west of Seventh Avenue, has been completed to the terminus of the line beneath Eighth Avenue. It should be understood that considerable lengths of the tunnel sections have been finished and lined, and that much of the steelwork has been put in place in the station on 41st Street between Seventh and Eighth Avenues.

The placing of concrete forms one of the most interesting features of this great undertaking, and the means employed by the contractor to do this are deserving of special mention. Compressed air has proved a prime aid in operating the facilities utilized in speeding up this part of the job. The pneumatic placing of concrete is not, in itself, a novelty; but conditions in the case of the Queensboro Subway Extension have called for apparatus which would be sufficiently flexible to deal with the continually changing demands.

Three concrete placers or "shooters," as they are called by the men on the work, are in service. Two of these are capable of shooting a third of a cubic yard of concrete at a time, while the capacity of the smaller outfit is one-sixth of a cubic yard. The placers were built by the Pneumatic Concrete Machinery Company and have been adapted by the contractor to meet his particular needs. One of the larger shooters has delivered concrete a total distance of 1,160 feet, sending the batch through a 6-inch line in which there were nine 90-degree turns. The material mounted a total of 67 feet on the journey—24 feet of which was a straight rise at the end of the run. As Mr. John J. Kennedy has expressed it: "One hundred per cent. of the stuff that goes into the mixer is shot into the forms, no matter how far the forms are away from the shooter."

The air pressures used have ranged from 65 to 80 pounds per square inch; and it has been possible to shoot a batch a minute with each of the outfits. In a day the three shooters have placed 157 cubic yards of concrete; and they have made it feasible to erect steel-work and to complete concreting close up to the advancing headings. In short, concreting has been done where it could not be placed by hand; and the machines have produced better and more finished jobs.

We have failed of our purpose if we have not made it clear that the building of the Queensboro Subway Extension is an undertaking of an especially hazardous nature—one calling for the execution of big and dangerous tasks in the very heart of a busy and intensely congested district of New York. Progress to date is the best evidence of the skill and resourcefulness of the men in charge.

The officers of the Powers-Kennedy Contracting Corporation are: A. J. Powers, president; John J. Kennedy, treasurer and general manager; Albert Carr, chief engineer; and Henry L. Kennedy, general superintendent.

Left—Meeting of finished and unfinished sections of south tunnel beneath the intersection of 42nd Street and Fifth Avenue. By reason of the pneumatic placing of the concrete the contractor has been able to follow close behind the rock excavators in erecting the steelwork. Right—Interior of one of the twin tunnels under 42nd Street, west of Madison Avenue, where the circular, concrete arch joins the rectangular steel and concrete lining. Bottom—Below 41st Street, looking into the portal of the south tunnel at the west end of the Seventh Avenue station.

Mica Known to the Ancients Has Many Modern Uses

How the Mineral is Mined and Subsequently Prepared For the Trade in This Country

By GUY E. MITCHELL

IT WAS not until the present "electrical age" that mica, one of the earliest known of the useful nonmetallic minerals, came to the forefront and began to supply a need that could not be filled by any other available substance. Its nonconductivity of electricity and of heat, its toughness, flexibility, and elasticity, make it especially suitable for the electrical manufacturing industry. Before the advent of electricity, mica was employed chiefly in place of glass, and for this purpose large sheets capable of perfect cleavage were required. At that period it was a serviceable but not an indispensable mineral; and much of the mica that was then regarded as waste is today utilized by converting it into mica board or "micanite"—that is, built-up mica. Imperfect sheets of mica are now also ground and used in the decoration of wall paper; in the manufacture of lubricants, fancy paints, rubber goods, molded mica, and roofing papers; for covering steam pipes; and in many other ways.

Even this brief description may give a broader conception of the present-day adaptability of mica than that formed by many of us not familiar with the mineral. As a matter of fact, a goodly number of people know mica only in the guise of the little transparent panes, which they have seen in stoves, and probably speak of it as isinglass. This name, which is incorrect, may have come about by reason of the fact that one of the early New England mica properties was called the Isinglass Mine. Isinglass is a whitish, tough, semi-transparent substance obtained from the insides of certain kinds of fish, and is therefore of animal origin. Mica, on the other hand, is a mineral.

More often than otherwise, mica is also considered brittle, whereas a thin sheet of good quality is really so flexible that it can readily be bent into a cylinder, one-fourth of an inch in diameter, without showing any cracking. The deposits of mica in the United States were created in the rocks millions of years ago under conditions of tremendous heat. Geologists tell us that the mineral is found only in crystalline rocks—rocks which are of great age and which were formed at least 5,000 feet below the surface of the earth's crust. Hence any region in which mica-bearing rocks are found must have been subjected to very long periods of erosion to carry away the overlying mass of rock and dirt in order to expose the outcroppings of the deposits.

The history of mica goes back to the days of the ancient Romans, who are said to have spread a micaceous sand or a disintegrated mica schist—a glittering, decorative material—over the arena of the *Circus Maximus*, where it was drenched with the blood of early Christians, or that of fighting gladiators and other victims of the Roman games. In India, mica has been produced for centuries; and in the days gone was used in lanterns and for various ornamental purposes, medicines, etc., while in European countries it principally served for 300 years or so to glaze windows.

The North American Indians are known to have mined mica extensively in the southern Appalachian States; and their old pits and trenches may still be found. These prehistoric mica miners bartered with the mound builders of Ohio for their product, as large mica sheets have been discovered in some of the old mounds. Stone hammers and axes are the only tools that have been found in the ancient mica workings; and with only these tools the aborigines dug 1,800 feet of large pits and trenches at the Sink Hole mine in North Carolina. Some of the excavations were 20 to 30

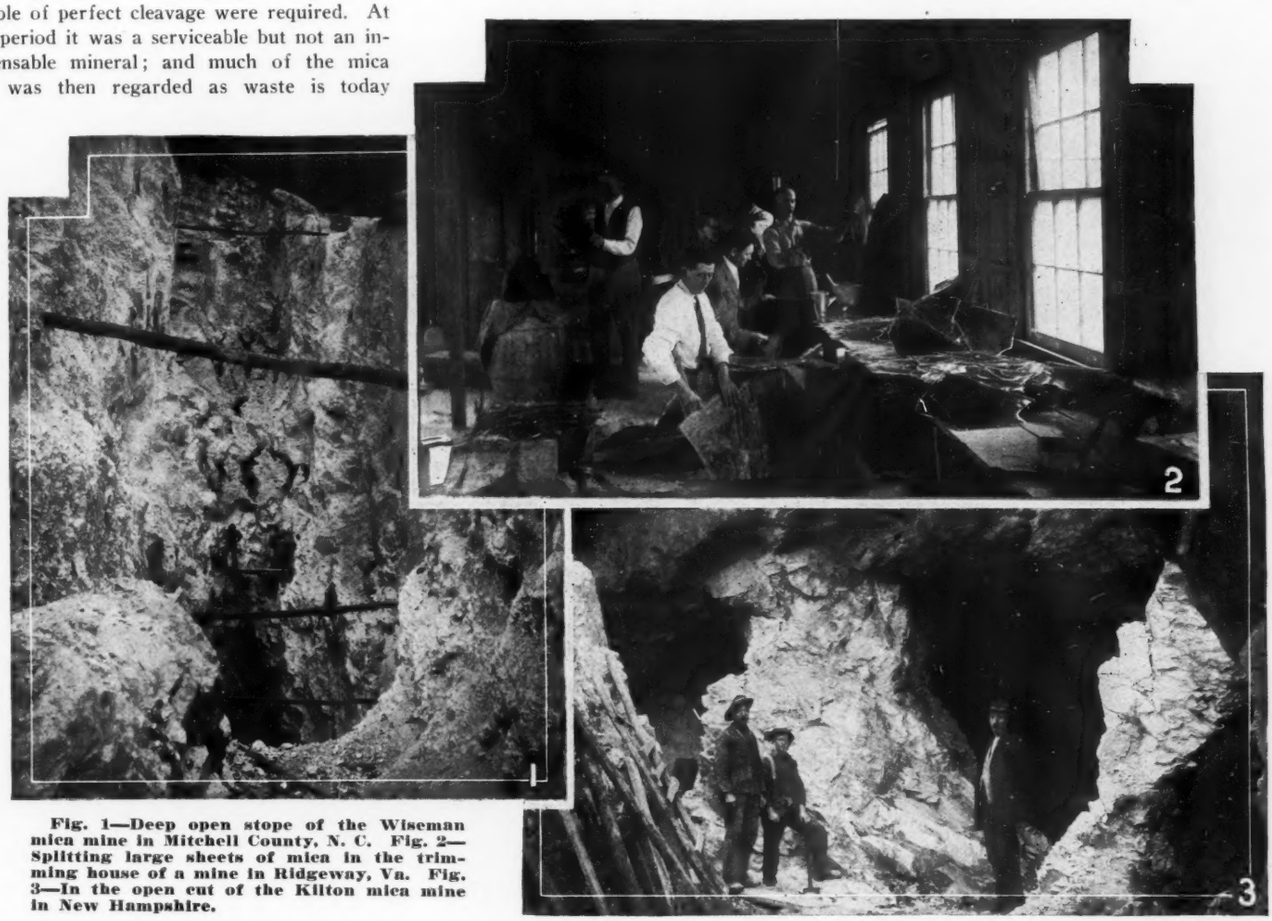
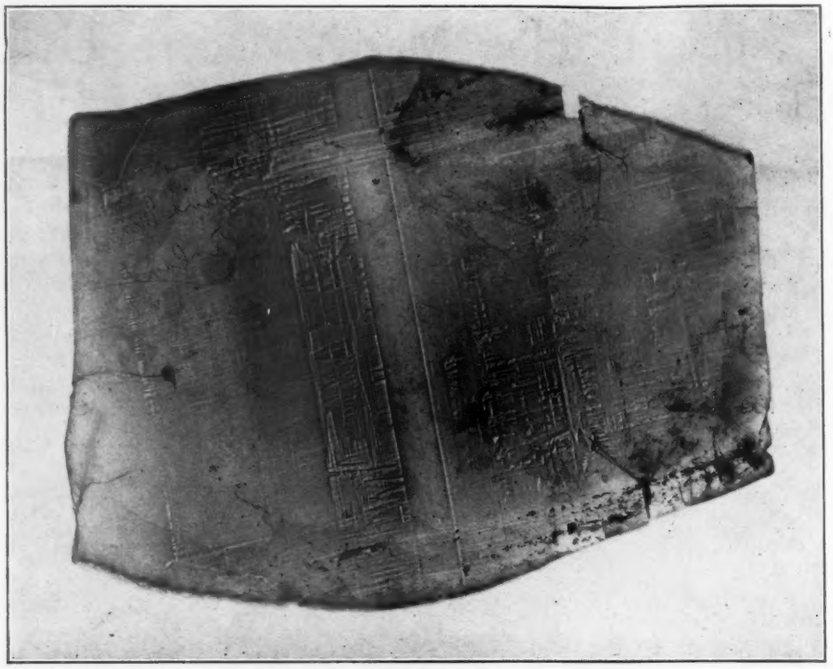


Fig. 1—Deep open stope of the Wiseman mica mine in Mitchell County, N. C. Fig. 2—Splitting large sheets of mica in the trimming house of a mine in Ridgeway, Va. Fig. 3—In the open cut of the Kilton mica mine in New Hampshire.



Sheet of mica with natural markings, which are suggestive of the hieroglyphics of the ancient Egyptians.

feet deep; and, at the time of their discovery by the white man, were overgrown with primeval forests that gave evidence of the great age of the workings.

As it lies embedded in the rocks, mica is a rather remarkable-looking deposit. It usually comes in rough blocks, often having irregular crystal faces. Fairly well-developed hexagonal or rhombic prisms are sometimes found in crystals of mica weighing hundreds of pounds. As generally taken from the mine, the mineral consists of rough crystals and blocks ranging in diameter from an inch to several feet. These crystals are split into sheets, about one-sixteenth of an inch thick, with wedges or splitting knives.

The introduction of micanite for use in the manufacture of electrical products has created a large demand for "thin splittings." These splittings are exceedingly thin—mere films of from one-thousandth to one-sixteenhundredth of an inch thick. Indeed, they are so thin that a mass of them feels like a pile of the finest tissue paper. In India, where most of the foreign splittings are produced, the work is done principally by women and children, while in our Southern States only children are employed for this service, which requires a delicate touch. For that reason children make the best splitters. The operation is performed either with a knife or with the thumb-nail, which is purposely allowed to grow long. From two to four pounds of splittings a day is considered a good output.

Young girls at work in a mica trimming shop where their nimble fingers deftly split sheets of the mineral.

These thin splittings are built up into mica board, flexible mica sheets, and tape. For mica board, layers of the splittings are cemented together and baked under pressure. The material so produced can be cut or punched and, when heated, can be bent or rolled into tubes and molded into collars, etc. Sheets of mica made in this fashion are used extensively between the commutator segments of motors and dynamos; and sheets, tubes, and other forms of mica are widely utilized in transformers and for washers and rings around bolts and screws requiring insulation. Large disks and washers of this kind are needful in every electric arc light and in the sockets of incandescent lamps; and mica, in one way or another, goes into spark plugs, fuse boxes, and telephones—as a matter of fact, the present-day uses of this mineral in the electrical industry are too numerous to mention here. But this is not the only field of service which draws heavily on the world's deposits of mica.

This adaptable substance serves as a substitute for glass in spectacles for stone carvers and metal workers, inasmuch as it is transparent and is not liable to be fractured by small flying chips of stone or metal. One of the latest applications of mica is in the manufacture of lantern slides by means of a special process that makes them scratch-proof. Lantern-slide "cover glasses" are also similarly prepared, thus greatly reducing the weight of the slides. As it would take page after page to tell of the many things that are wholly or partly fashioned of mica, we shall mention just a few more for the purpose of giving the reader an idea of the diversified uses to which this mineral is put. Because of its heat-resisting qualities it is combined with rubber in making automobile tires; mixed with oil it produces a fine lubricant; and an admixture of powdered mica and starch applied to cheap cotton goods gives them an attractive sheen. Lastly, the value of mica as a lagging for steam pipes and boilers, to prevent the radiation of heat, has been determined by careful experiments.

Competitive tests made by the Canadian Pacific Railway revealed that the temperature of boiling water placed in a 14-inch cubical tank covered with mica was reduced but 20 degrees at the end of five hours. When protected with asbestos and wood, it was lowered 30 degrees; with magnesia blocks, 34 degrees; and with asbestos compound, 53 degrees. With the tank bare, the heat loss in the same period amounted to 84 degrees. Furthermore, experiments conducted by the Grand Trunk Railway with different lagging materials showed that mica conserved 92 per cent. of the heat of a locomotive boiler that would be lost if bare, and that it is twice as effective as a covering of sectional magnesia blocks.

Although many attempts have been made to find a satisfactory substitute for sheet mica, so far none has proved successful, and the indications are that the mining of the mineral will

go on for years without fear of slackening. As a matter of fact, with the growing applications of electricity—requiring insulation against ever-increasing voltages—the demand for sheet mica of good quality must become greater.

A few of the makeshifts that have been placed on the market are: oiled-paper and compressed-paper substances; a product manufactured from kelp; bakelite, a synthetic material made from carbolic acid and formaldehyde, which is said to be a promising substitute for built-up mica board; and pertinax, a compound developed by the Germans during the World War because of a shortage of mica. The inefficiency of the German airplanes, as compared with those of the Allies, was, in part, ascribed to the use of pertinax in place of mica.

Mica mining in the United States began in 1803 with the opening of the Ruggles mine in Grafton County, N. H.; and other New Hampshire mines, subsequently developed, furnished practically all the mica used in this country until after the "fifties." Then discoveries in North Carolina shifted the center of production to that region.

As a general rule, a mica mine should be opened by cuts, shafts, or tunnels along the deposit, wherever the prospects appear favorable, until mica has been found in paying quantities. Only then should vertical shafts be sunk either in the mica-bearing pegmatite or at one side of the vein, or long crosscut tunnels should be run from lower levels on a hillside. Few properties give evidence on the surface that they will warrant extensive development.

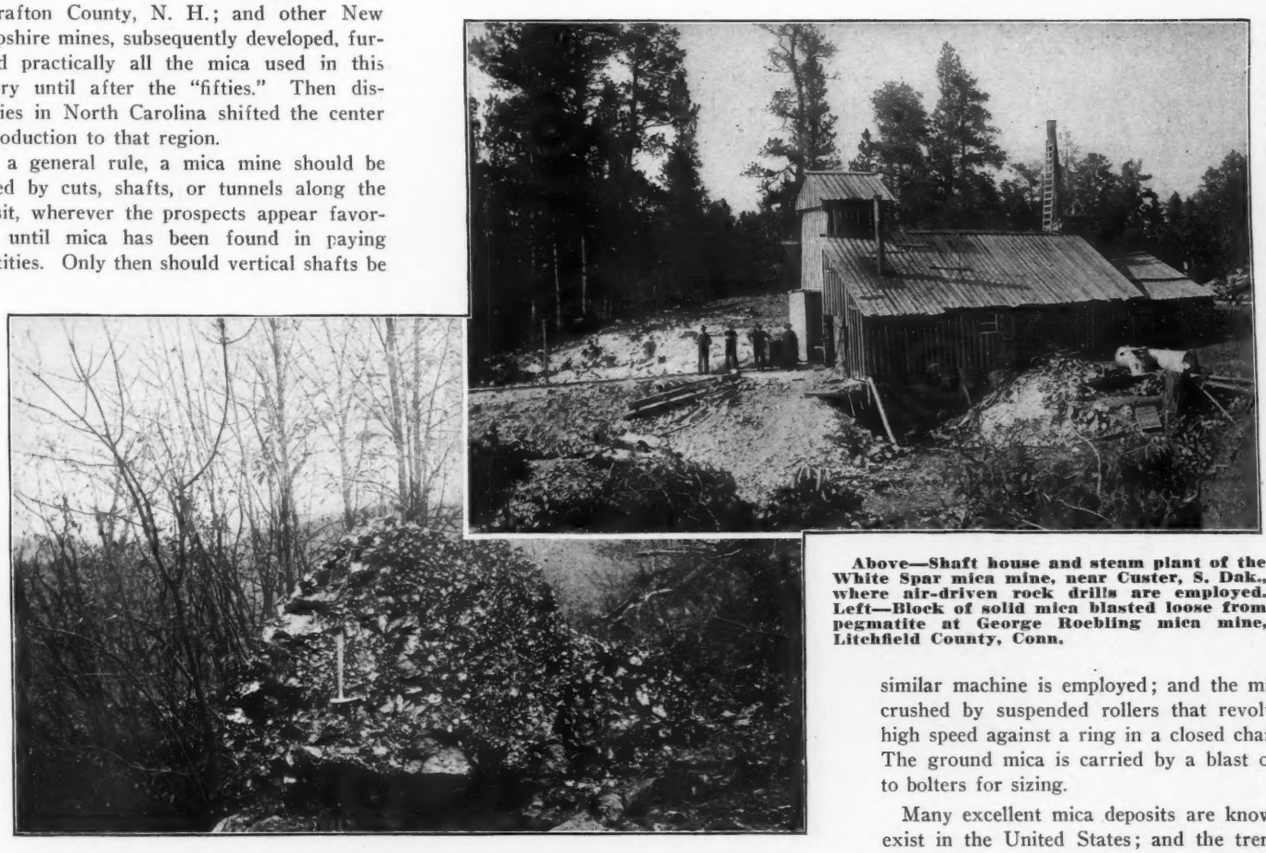
Even to this day, many of the small mica mines in the United States are laboriously worked by hand drilling just as they were generations ago; but where they are sizable and of much importance the practice is to employ pneumatic drills in the same way preparatory to blasting as they are in other fields of mining and quarrying. The operative air is furnished by steam, gasoline, or electrically driven compressors. Great care must be exercised in drilling to avoid damaging good crystals of mica. The experienced drill runner, by the mere "feel" of the tool making its way through the rock, can tell the moment it leaves the hard, inclosing pegmatite and reaches the less-resistant mica. He instantly stops the drill before it has damaged the inclusion by piercing the mica even a fraction of an inch.

Very little of the raw mica goes to waste; and the sort suitable for grinding will bring from $10 to $12 a ton, while the price of large sheets of mica is as high as $1,000 or more a ton. According to the United States Geological Survey, we produce annually anywhere from 1,000,000 to 1,500,000 pounds of sheet mica and about 3,000 tons of scrap mica. The value of this raw material at the mines is estimated at $500,000; but by the time it reaches the consumer in one form or another it is worth a good deal more than that.

The rough, small pieces of mica and the waste in trimming the large sheets are ground fine to supply the big and growing demand for powdered mica for decorative purposes, lubricants, etc. Grinding is done both by wet and dry processes. The method of wet grinding employed is unique, inasmuch as it is a shredding rather than a crushing operation. The grinder is a simple apparatus: a heavy, wooden wheel attached to a vertical power shaft which revolves in the center of a large, cylindrical vat. After washing, the stuff is delivered to the vat with just enough water to give the desired lubrication. The wheel is then started and pressed down by means of a spring until it takes a firm hold upon the mica. The friction of the wheel exerted against the mass causes the layers of some of the mica to be forced between the opposing layers of contiguous pieces, and thus the material is gradually torn apart and reduced to the pulverized mica of commerce. After from eight to ten hours of grinding the mill is emptied; the fine stuff is separated from the coarse mica by a system of flotation; and the coarse mica is returned to the mill for retreatment. The second lot of fines so produced is allowed to settle, and the water is then drawn off. Subsequently, the mica is dried on tables and is next placed in bolting machines, somewhat like those used for bolting flour, where the last trace of coarse material is removed. The latter is again returned to the grinding mill. One such mill will produce but from 250 to 400 pounds of 160-mesh mica per day—hence many mills are necessary for a large output.

For dry grinding a Raymond pulverizer or similar machine is employed; and the mica is crushed by suspended rollers that revolve at high speed against a ring in a closed chamber. The ground mica is carried by a blast of air to bolters for sizing.

Many excellent mica deposits are known to exist in the United States; and the trend of production is increasing. The imports, however, are generally greater than the domestic output, despite the fact that our mines could be made to supply all our needs, except those moderate and special ones that call for the softer "amber" mica that is found in Canada.



Above—Shaft house and steam plant of the White Spar mica mine, near Custer, S. Dak., where air-driven rock drills are employed. Left—Block of solid mica blasted loose from pegmatite at George Roebling mica mine, Litchfield County, Conn.

The wanderings of fish in picking up a living we cannot trace, but we know that mysterious means of information and unerring instinct enable them to return for spawning to the streams where they were hatched. The Bureau of Fisheries, Washington, D. C., records that a salmon, caught at a feeding ground south of Alaska and tagged No. 10,358, was taken again six weeks later in a Siberian stream 2,000 miles away. The fish was cleaned and salted before the tag was noticed.

SUGGESTION FOR LESSENING MINE HAZARDS

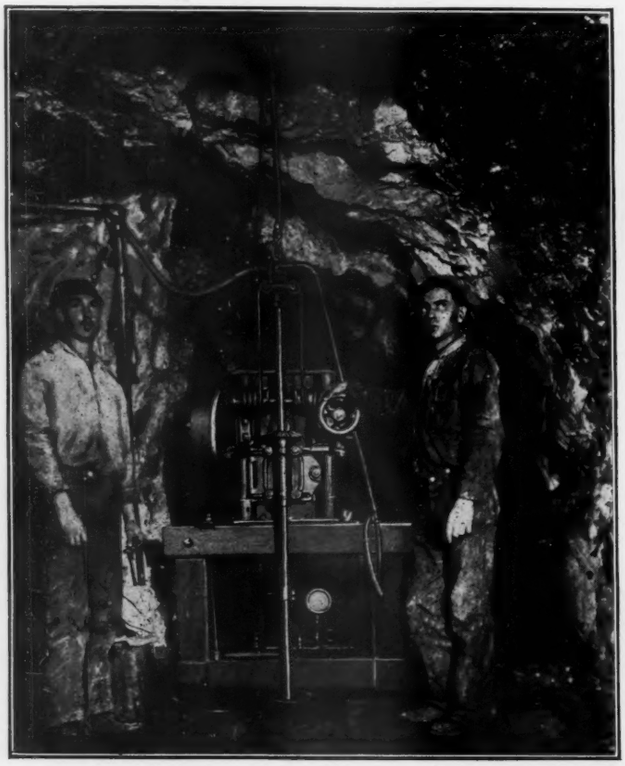
By F. MILLER

NOT long ago, a western paper contained the following headline: "Mine No. 2, which was transformed into a shambles by a terrific triple explosion, today continued to give up its dead."

That story was but a repetition of kindred catastrophes that have shocked the country of late. We still have in mind that disaster in a famous California mine which cost 26 men their lives; and thus every once in a while we hear of other sacrifices in this field of industry just when we have been lulled into a sense of false security. The writer, who has worked in mines where the ventilation has been none too good, is of the opinion that more attention should be paid to a means of communication with the surface other than the shaft, lest the regular exit become blocked by an explosion, fire, or cave-in.

There is one method in particular that might be used as a possible safeguard against loss of life, where a party of men are trapped underground through one cause or other. We will suppose that bore holes are drilled from the surface to the lowest levels; that each bore is lined with galvanized piping; and that at each level, through which the bore passes, the pipe is fitted with a tee and a brass screw plug—this plug with a wrench to be chained to the pipe to prevent loss. By drilling a bore hole of 8½ inches, plenty of room would be provided for the insertion of a 6-inch pipe. The size of the bore is, of course, optional, as it is possible by means of the Calyx core drill to bore holes up to 20 inches in diameter through a solid formation.

Several such bore holes in a mine would always be a big asset to a group of trapped miners, as they would offer not only a ready means of communication with the surface but might also facilitate the sending of foodstuffs and drink down to the entombed men. Not only that, but they could be made to serve as air lines, reaching from one level to another, provided the tee connections were not so blocked as to render the screw plugs inaccessible in case of accident. There is no doubt that lives could thus be saved; and scenes that now take place around the collar of a shaft after a disaster would have no reason for occurring.



Calyx drill driving a vertical hole.

Calyx drill at work on an oblique hole.

PETROLEUM AND PIPE-LINE FIGURES

THE official figures of the United States Geological Survey give the production of crude petroleum in the United States from 1859 to 1922, inclusive, as 6,459,582,000 barrels. In 1922, the total output was 551,197,000 barrels. Practically all this oil, at least in some stage of its progress to market, now requires the use of pipe-line facilities. Today the pipe lines of the country are carrying about 2,225,000 barrels each 24 hours—a matter of 598,810,000 barrels having been so transported in the first ten months of 1923. In this connection, it is interesting to note that one pipeline company is linked up with 31,000 wells in one state alone. These facts are compiled from an interesting paper presented by D. S. Bushnell, President of the Buckeye Pipe Line Company, at the annual meeting of the American Petroleum Institute.

FACTS ABOUT TERRESTRIAL CENTRIFUGALITY

ATTENTION has been called recently to the difference in the weight and the displacement of a ship steaming east and one steaming west on account of the centrifugal force acting upon it. A specific example is cited of an American 1,100-ton destroyer traveling westward at 25 knots and adding 262.8 pounds to her weight, while the same craft speeding eastward would subtract 480.628 pounds from her weight.

The Engineer, London, has taken pains to look into the matter and gives us some additional facts. Inasmuch as a vessel running at 25 knots has a speed of 42 feet per second, and as the peripheral speed of the earth at the equator is 1,560 feet per second, it is clear that in steaming westward, with the two speeds opposing each other, the true linear velocity of the ship would be 1,518 feet per second, while on an eastward course it would be 1,602 feet. The centrifugal force exerted on a vessel of the aforesaid size and speed is 8,410 pounds on a westward course and 9,366 pounds on an eastward journey—indicating a difference of 956 pounds between the two conditions.

The sum of the figures first given is 743 pounds. The discrepancy is easily accounted for. We are not told to what latitude the American value is related; but a simple calculation indicates that it is based not on the velocity of the earth at the equator but on a peripheral speed of 1,213 feet per second. This is the surface speed of the earth in latitude 39 degrees—that is to say, approximately in the latitude of the Brooklyn Navy Yard or, more precisely, the latitude of Baltimore.

LIFTING A GREAT MASS OF ORE AT ONE BLAST

A GIANT shot of 83,600 pounds of explosives—consisting for the most part of what is known as "Sikrit"—was fired not long ago at the Sydvaranger iron mines, which are located on the northeast coast of Norway. So tremendous was the force of the blast that a solid mound of ore, 131¼ feet high, was shattered into pieces small enough to be readily handled by steam shovels. It is said that the explosion lifted approximately 250,000 tons of high-grade iron ore. Visitors had come from far and near to witness the scene, which was, indeed, a spectacular one. Great columns of fire and smoke attended the blast; and the snow, throughout a radius of about three-quarters of a mile, was covered with a mantle of black dust scattered by the explosion.

At the time, this shot was claimed to be the largest ever fired—exceeding the previous record made during the construction of the Panama Canal by 22,000 pounds. Since then, however, another very much larger blast was fired at Lakeside, on the west shore of Great Salt Lake, Utah. As previously described in the Magazine, 300,000 pounds of Hercules dynamite was used to shatter a mass of rock 1,000 feet long and 275 feet high. We are indebted to K. Lund & Company, Christiania, for the interesting information about the blast at the Sydvaranger mines.

GROWING NORTHWARD

WE ARE continually reaching out and appropriating the outlying regions of the earth that have hitherto been regarded as of little worth. This is notably true of the northern portion of the American Continent. Port Nelson, on Hudson Bay, is to be the terminus of the Hudson Bay Railway; and an expenditure of over $20,000,000 is planned for buildings and equipment that will promote the commerce expected to develop. A great fur country is now to spend $4,500,000 for wheat elevators; and astonishing revelations in oil, coal, and metals—to be had for the mining—would seem to point to much industrial activity and to untold wealth in the near future.

A notable display of pneumatic tools, air-operated drills, compressors, and pumps, which attracted many visitors during the Public Works Exhibition recently held in London. These facilities represent the present climax in the restless effort to save labor and yet to speed up performance in numerous lines of work. Their outstanding fields of service are in mining, in great structural undertakings, and in all sorts of tasks where ground has to be broken and where buildings have to be remodeled or razed.

SCRAPPING A FULTON RELIC

PROBABLY the last surviving relic of Robert Fulton's actual connection with the development of steam navigation goes out of existence with the recent dismantling of the steamboat *Norwich*, so long familiar on the Hudson River. She was designed by Fulton in 1836, and was known as the *Ice King* when she used to keep a passage open in that stream for the Erie Railroad to Piermont, N. Y.—the first and for a long time the only rail connection between New York City and the West. Her bell is in the Senate House at Kingston, the meeting place of the state's first Assembly.

POWER POSSIBILITIES OF TATIO

ENGINEERS, who have successfully generated power from the heat of volcanoes in Italy, have been investigating the great volcano Tatio, between Chile and Bolivia, in the light of a possible power producer. They assert that the steam issuing from Tatio, if properly harnessed, could be converted into the electrical equivalent of 500,000 tons of coal annually. The steam was found to be free from impurities. In other words, it could be run directly into the turbines, thus obviating the heavy expense of complicated cleansing apparatus.

NON-TARNISHING SILVER

IT IS somewhat unaccountable why silver has so long retained its standing as a precious metal when it tarnishes so easily; and Sterling silver is worse than pure silver because of the copper alloy which is used to harden it. Now that we have stainless steel, why may we not have non-tarnishing silver? Alloys already tested at the Bureau of Standards have proved themselves to be much more resistant to tarnishing; and we are encouraged to believe that complete success will yet be attained. We shall be wanting a spoon of the new metal for eating our boiled eggs in the morning.

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EDITORIALS

SOUTH AMERICA

SOUTH America is today in the condition that the United States was some 50 years ago—a large territory with rich, undeveloped resources. The process of development through American capital has been slow, and this has largely been due to the facts that we have been too busy at home and that few heads of industries in the United States have been in personal touch with the countries to the south of us. Development has also been retarded by the natural feeling of the South American peoples against the United States. As in the past, they still look upon us as a great, rich power assuming the position of a creditor and reaching out to absorb the wealth and even the territories in other American fields. When we took Panama to build the canal, a hard blow was given to the efforts that had been made to create friendly feeling in Latin-America. This situation was somewhat ameliorated by our moderation in the case of Cuba; but it was not cured. The World War has probably done more than anything else to convince the peoples to the south of us that America is not seeking territorial aggrandizement. The trend of the spirit of the times is towards the protection of smaller nations throughout the world.

As to capital, it is a common thing to hear people say that all that Latin-America needs is capital. Latin-Americans are not reaching out for capital in the United States unless that capital is of the coöperative kind: capital that takes into consideration the rights of the owners of the property and that acts with and through them as partners. This is the true way to develop Latin-America through United States capital.

Immigration will do much to stimulate progress in Latin-America. The Latin spirit is not aggressive: it is thoroughly human, somewhat altruistic, and conservative. They are proud of their traditions. The get-rich-quick idea does not prevail there. With immigration, which is very apt to turn in that direction because of restrictions in the United States, an element of speculative activity is likely to result. In other words, the mixture of new blood, especially that of Anglo-Saxon, Scandinavian, and Teutonic races, will inevitably lead to industrial progress.

FUEL REVOLUTION IN NEW YORK CITY

SOME revolutions make a great noise in the world even before they begin; and then they are continually heard from at all stages in their progress until they come to an end. Other revolutions are heard from only after they are far advanced or accomplished. The fuel revolution in New York City—it cannot be called anything less than that—belongs to the latter class. We speak, of course, of the employment of oil in large steam-generating units in place of coal. The public is sufficiently informed of the extensive adoption of oil for marine service, both naval and commercial, but of the more recent and rapidly growing use of oil on land, especially in New York City, comparatively little is heard.

Up to December, 1919, less than four and a half years ago, the burning of fuel oil was unknown in New York, while today the practice is so extensive and gaining so steadily in favor that it is impossible for us to enumerate examples with any satisfactory detail. We can mention only the large hotels, the department stores, and the big office buildings. One of the first of the hotels to adopt oil for fuel, so we learn from *Oildom Daily*, was the Ritz-Carlton, whose plant has been in operation for two years. During the first six months, the system saved the management in fuel, $17,000; in labor, $5,424; in ash removal, $2,388; and in repairs, $678—a total of $25,490. Similar systems have now been installed in more than a dozen of the other large New York hotels.

The same story can be told of the department stores in the shopping district, of the big apartment houses uptown, and to a greater extent of the modern skyscraper office buildings throughout the business sections of the city. The Equitable Building, using about 10,000 gallons a day, has a 5-year contract for oil at 4½ cents a gallon. The Petroleum, Heat & Power Company, of New York, reports that during January it received more contracts for the installation of oil-burning equipment than in any previous month in its history, in which time it erected 1,000 units consuming between 2,500,000 and 3,000,000 barrels of fuel oil annually.

We take special interest in all these lines of development because, as the readers of *Compressed Air Magazine* need not be reminded, compressed air is the active and indispensable co-worker with the oil in all its activities.

HELPING THE STATE THAT HELPS ITSELF

CONSIDERED from all angles, the assertion is boldly made that North Carolina is now the most prosperous state in the Union. It is said to be making relatively greater agricultural, industrial, and educational progress than any other state in the Union. This advance is largely attributed to the excellent work that has been done there in the building of splendid highways on a scale not equalled by any other commonwealth of its size. An admirable advertising scheme is being formulated that will effectually tell the world what North Carolina is doing for itself and that will, at the same time, boom roadbuilding generally throughout the length and breadth of our land. The matter is being enthusiastically pushed by our esteemed contemporary, the *Manufacturers Record*, and all that can should be glad to give it a boost.

Some 40 or 50 engineers and officials from South American countries are visiting the United States this summer; and the American Road Builders Association is planning to give them, as well as a large number of invited guests of high standing from many parts of our own country, a chance to see the "Tar Heel" State. Roadbuilding projects, in various stages of completion, together with all the tools and machinery employed for the work, are to be shown the guests; and the hundreds and hundreds of miles of fine roadways which the throng will travel by automobile will speak for themselves and open to the mind's eye vistas of future possibilities.

LUBRICATION

THE LAST word has not been said and the last question has not been asked concerning lubrication—if, indeed, it has been said and asked upon any other practical topic. The lubricating function in some guises is far reaching, and applies virtually to all mechanically moving devices of man's contrivance. It applies also, and more extensively, to the created world in general, though we are slow to appreciate or even to recognize the insistent examples which Nature exhibits so universally.

We cannot be ignorant of how smooth and slippery is the skin, for instance, of a fish, especially when alive; and we should know also, only we mostly have not thought of it, that this fishy condition is a form of lubrication provided to facilitate the easy gliding of the body through the water—thus contributing to speed of movement and to economy of propulsive effort.

This compels the inquiry: Why are the submerged surfaces of our ships not as smooth and as slippery as the skins of the fishes in the sea? The answer obviously is that it is im-

possible artificially to produce such a condition in its entirety. Even so, we cannot be without reproach so long as we do so little to approximate the conditions which Nature so insistently suggests. Models of ships have been thoroughly studied and exhaustively experimented with; but we are only at the beginning of our lesson in the matter of lubricating submerged surfaces and of minimizing skin resistance.

The problem of the easy passage of a ship through the water applies equally to the navigation of the air. Unquestionably the smooth and easy slipping through the air of the gliding surfaces of flying machines is of the greatest importance; and here, too, we have been backward in our studies and researches.

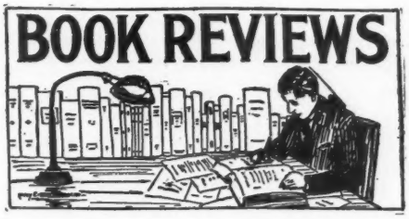
Nature gives us instances on every hand of perfect mechanical lubrication—lubrication which is automatic, constant, and sufficient—in the moving joints of all living animals from the elephant to the mouse, and from the knee of the mouse to the wing of the gnat, or whatever moving part may be in the minutest microscopic organism. In all these instances, the lubricant and the function of lubrication are provided for in the design, the development, and the maintenance of the mechanism; and the lubricant is as much a constituent of the working part of the whole mechanism as is the bone or the muscle.

In man's mechanical contrivances, lubrication even to this day is not infrequently what might be termed an afterthought: it is something that is adopted only upon compulsion. When the wheelbarrow began to squeak we learned to oil it to stop the noise; and that was the beginning of our efforts towards lubrication. We have got far beyond that point now; but we still have far to go.

It is apparent that the desire of the people of the Middle-West for a direct outlet to the sea is not as new as we may be inclined to imagine. A petition has recently been found among the old records in the Public Library of Superior, Wis., which asks for the improvement of the St. Lawrence River so that ocean-going ships may pass to and from the Great Lakes via that waterway. This petition was signed in 1850 by 87 pioneer residents of the Northwest.

George W. McNulty, a well-known New York City contractor, died recently in the New York Polyclinic Hospital at the age of 72. Mr. McNulty was a graduate of the University of Virginia, and assisted Colonel Washington Roebling in the building of the Brooklyn Bridge. After the completion of that structure he engaged in the contracting business and, among other undertakings, installed the cable system for the Broadway surface cars; constructed the subway from Times Square to Columbus Circle; and laid out the Sunnyside yards of the Pennsylvania Railroad.

For a number of years Mr. McNulty was a governor of the Engineers' Club, of which he was one of the oldest members; and he held the rank of major in the National Guard. He is survived by his wife, two sons, and a daughter.



PULVERIZED AND COLLOIDAL FUEL, by J. T. Dunn, D.Sc., F.I.C. A work of 197 pages well illustrated, published by Ernest Benn Limited, London. Price 25 shillings, net.

WHILE viewed primarily from a British standpoint, the author's handling of his subject furnishes information which should be of interest to fuel users the world over. Indeed, what Mr. Dunn tells us sounds pretty much like our own story in the exploitation of our coal mines and the use of their output. Let us quote just one paragraph to illustrate this:

"Our coal resources are being drawn upon at a very rapid rate. * * * The more accessible and easily worked seams, and those of the best quality, are naturally worked first; many of them are worked out, others are approaching their end. Seams more difficult to work and of poorer quality have to take their place, and the supply of coal tends, both in consequence of that and because of the higher cost of labor, to become continually more costly. Economical and efficient use of our coal, therefore, is not merely a desirable thing from the point of view of saving our own pockets and of making our industry a greater pecuniary success. It is a duty we owe to the nation not to waste its resources, and a duty we owe to posterity not to deprive them recklessly of their inheritance. Any improvement in the methods of utilizing our fuel which will either, by securing better combustion, yield us more heat from the same fuel or, by lessening waste of the heat when obtained, enable us effectively to obtain the same amount of heat from a smaller amount of fuel, or which will allow us to use as fuel coals which hitherto it has not been possible to use—any such improvement demands consideration at the hands of all who are concerned in the use of fuel for industrial purposes."

LABOR IN THE COAL-MINING INDUSTRY (1914-1921), by G. D. H. Cole. A work of 274 pages, published by the Oxford University Press, American Branch, New York. Price, $2.50.

THE book is a historical treatment of the coal-mining industry of Great Britain from the outbreak of war to the first half of 1921, and was undoubtedly inspired by a desire to develop from the facts of that period material which would be conclusively of economic and social value. The author, however, regretfully admits that his task has not proved one capable of satisfying accomplishment. Even so, he has brought together a wealth of information which will inevitably prove illuminating and, perhaps, suggestively informative.

As Mr. Cole says: "To a peculiar extent, the problems raised by State control came to a head, in the case of the mines, only after the termination of hostilities in November, 1918; and the campaigns and disasters of 1920 and 1921 arose directly out of, and were intimately bound up with, the control of mining operations and mining labor originally imposed as a war measure. With the exception of the railways, the mines were the last industry remaining under this system of State control, and even in 1921 control was terminated only to the accompaniment of great industrial upheaval, and of serious loss and utter dislocation to the industry itself."

POPULAR RESEARCH NARRATIVES, collected by Engineering Foundation and published for that organization by Williams & Wilkins Company, Baltimore, Md. A book of 152 pages. Price $0.50.

THIS is really a fascinating volume containing fifty 5-minute stories of research, invention, and discovery, told in a clear and pithy manner by the "men who did it." The language used is that familiar to the layman, young and old; and anyone seeking authentic tabloid information about many of the things which make modern life marvelous should possess a copy of this entertaining and worth-while book.

PROSPECTING, A HANDBOOK FOR CANADIAN PROSPECTORS, by W. L. Goodwin, D. Sc., LL. D., late Dean of the Faculty of Science, Queen's University, Kingston, Ont. A work of 326 pages, copiously illustrated, printed by the Industrial and Educational Publishing Company, Gardenvale, Que. Price, $3.00.

IN A land of enormous mineral wealth, which is undoubtedly far richer than now known, the ultimate opening up of this vast treasure house will in part depend largely upon the pioneer efforts of the prospector. Realizing how much may be missed or unseen by a prospector unfamiliar with the revelations of outcropping minerals, Doctor Goodwin set himself the task of preparing a compact and convenient-sized handbook which would serve for the instruction and the geological guidance of men bent upon finding and evaluating Canada's far-flung mineral deposits. The volume is ample evidence of the skill and the thoroughness with which he has performed his task.

As Doctor Goodwin puts it: "This book has been written for prospectors working in Canada, and most of the mineral deposits herein described are therefore Canadian. But it is hoped that the volume may be found generally useful to all who are interested in the discovery and development of mineral deposits and in the advancement of mineral industries."

An Unusual History of Petroleum takes up the story of this mineral oil ten million years ago and hits the high points at intervals between then and now. The preface of this semi-serious brochure tells us: "Learned scientists have written many treatises on the origin and development of the uses of petroleum. These works are based on facts—big volumes—and heavy. We know. We have read them. A year ago we came to the conclusion that these facts should be boiled down to folder size and seasoned with a flavor of pure fancy. *An Unusual History of Petroleum*, in twelve installments, was the result."

The pamphlet is issued by The Tide Water Oil Sales Corporation, 11 Broadway, New York City, and a copy can be had for the asking by anyone interested in the subject.

COMPRESSED AIR IN THE ICE PLANT

By C. W. GIBBS

THE growth of the raw-water method of manufacturing ice has brought the air compressor to the front as one of the most important auxiliaries in the ice plant. The compressor, itself, is generally given fairly good attention; but all too often the operator fails to realize that the other parts of the air system also require frequent inspection and care.

Most plants are equipped with air compressors designed to maintain a pressure of 30 pounds gage in the dehumidifiers and mains—this pressure being reduced to from 12 to 15 pounds gage at the brine tanks. An unloader is usually furnished on each compressor to close the intake completely when the predetermined pressure of 30 pounds is reached, thus reducing the delivery of the machine to zero and the load on the motor to a minimum value. When the line pressure has dropped two or three pounds, the unloader again opens and permits the compressor to deliver its full capacity. This unloading results in a direct money saving to the plant in lower power bills.

It is advantageous to provide a compressor somewhat larger than the average demand so as to take care of unusual conditions and to allow for the slight leakage which will occur in practically every plant. Care should be taken, however, that this excess capacity does not cause a let up in the search for leaks and for points of waste.

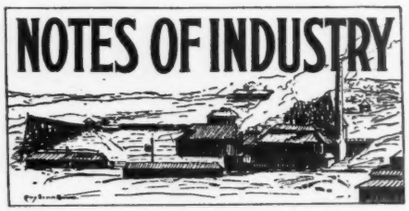
Complaints are often made that the air compressor is not delivering its rated capacity when, in fact, the fault lies elsewhere. Lack of control of the quantity of air flowing to each can, and punctured tubes leading from the laterals to the cans, are the most common sources of air loss. Valves are as a rule provided that permit an adjustment of the amount of air for each can, and they should be used. The tubes are easily damaged by the cans when the latter are lifted from the tank or lowered into it; and only constant care and attention will prevent a waste of air at this point.

Proper attention, in many cases, is not given to the piping to and from the air compressor at the time the installation is made. This may reduce the output of the unit as well as increase the power requirements. Long intake pipes are often used in ice plants, although the practice is contrary to good engineering. The intake pipe should be as short and as free from bends as possible. Where long pipes are necessary they should be increased in diameter at least one inch for every ten feet of length. In dusty places the service of an air filter is strongly recommended, as the elimination of dust will greatly reduce compressor valve troubles. There are a number of good filters now on the market.

An air receiver should be connected to the discharge line and put as close to the compressor as practicable. The discharge line should be the full size of the compressor discharge opening. The absence of a receiver often causes avoidable surges and frictional losses in the discharge line, and this lack of needful equipment shows up in the higher bills. The employment of a suitable receiver, properly connected, will save money.

Where there are a number of air compressors it seems to be the general practice to have a common discharge line and a common intake line for all of them. It is much better to have a separate intake and a separate discharge pipe for each unit, bringing the discharge pipes together at the receiver, if necessary.

Care in installing the air system of an ice plant and care in its use are as important as proper care of the ammonia system. This foresight and consideration will pay in the long run.



Further proof of the effectiveness of Maxim silencers on air compressors is given by the following new installations: Edward G. Budd Manufacturing Company, Philadelphia, Pa., one 12-inch intake silencer; Doubleday, Page & Company, Garden City, Long Island, one 15-inch intake silencer; and the Interborough Rapid Transit Company, New York City, one 8-inch compressor-intake silencer.

Mr. L. D. Albin, formerly General Sales Manager of the Ingersoll-Rand Company, 11 Broadway, New York City, has been elected Vice-President in charge of European sales of that Company.

Mr. D. C. Keefe, formerly Assistant General Sales Manager, has been appointed to succeed Mr. Albin as General Sales Manager.

The Danish Society for the Culture of Silk and Mulberry Cultivation has just published a report covering the 23rd year of its activities. Although the weather conditions in 1923 adversely affected the silkworms, it has been proved that sericulture can be carried on with good results even in cool climates. Last year 75,000 pasteurized silk eggs were imported from France and distributed among the various silk growers, while about 33,000 cocoons were produced and shipped to Italy to be spun into yarn.

In order to meet the increased cost of production, the operators of French collieries have given special attention to mechanical equipment suited to local conditions. As a result, the output in one district has been increased from 4.27 per cent. in 1913 to 16 per cent. in 1922. This modernizing of the coal mines is also reflected in the increased use of compressed air for various purposes.

According to the latest national census, Brazil has 30,635,605 inhabitants, including a foreign population of but 1,565,961.

This year, Canada takes her place as the greatest wheat-exporting country in the world, with the practical certainty of indefinitely retaining that lead by an ever-increasing margin. Canadian authorities confidently assert that the present generation will never see the time when the wheat exports will fall below those of any other country. Most of the wheat acreage is in Western Canada; and there the growth has been phenomenal. During the 5-year period preceding the war, the average exports annually amounted to 80,000,000 bushels, while now they exceed 300,000,000 bushels.

The Ceramics Department of the University of Saskatchewan has found through its investigations that extremely fine bricks can be made from the waste products of the brickyards at Claybank. The hardness of these bricks makes them superior for building; and their color as well as their roughness of surface enhance their value for finishing purposes.

A new fire-hose nozzle has recently been developed which is said to possess marked advantages over the simple, round hose discharge. By means of it the water is delivered in a wide-spreading sheet which is likened to an umbrella when in a horizontal plane. Water so applied forms a protective screen for the firemen—enabling them to approach much nearer to the blaze, and it also intercepts the air rushing to the flame, in this way making it possible to suddenly extinguish a gasoline fire. The nozzle can be held with ease by one man when there is 150 pounds pressure on the line.

A fibrous material composed entirely of wood, which is more delicate than our "excelsior" and produced by a different process, is coming into use in England for packing purposes. It is shredded from round logs and is made in different grades. The finest, quite resembling wool, is utilized for putting up chocolates, a coarser kind for eggs, and so on. It is also turned out in continuous paper tubes, called wood-wool sausage, and in this form, cut in the desired lengths, it is admirably suited for winding around delicately carved furniture, the rounded corners of pianos, in short, anything that should be protected against impact while in transit.

Alunite, from which alum is produced, is coming into prominence for fertilizing purposes. It is reported that a corporation, operating alunite deposits on the west coast of Vancouver Island, has received an order from Australia for 30,000 tons of alunite fertilizer. The plant has a capacity of 100 tons a day. The alunite deposits at Marysville, Utah, are also being worked to take advantage of the world's markets.

An exhibition of commerce and industry will be held in Tilburg, Holland, from July 18 to August 18, inclusive. It is to be a display of Netherland's manufactures and commodities, and is also intended to give foreign countries an opportunity to show their products. Tilburg is the center of the industrial district in the south of Holland.

Big High-Pressure Air Tank Built to House a Wind Tunnel for Testing Airplane Models

THE completion of the compressed air wind tunnel at Langley Field, in Virginia, marks an important step forward in the field of experimental aviation. The tunnel was built under the auspices of the National Advisory Committee for Aeronautics, authorized by Congress to conduct extensive researches in the art of aerial navigation, and, according to this body, "the information to be obtained from the apparatus will be the most important ever given airplane designers."

Courtesy, The Boiler Maker.

The great pressure tank within which the wind tunnel is installed. Photograph was taken just before the tank left the builder's yard.

The 5-foot tunnel, in which models having a maximum span of two feet can be tested, is housed in the largest compressed air tank ever constructed. This great air chamber, which was built by the Newport News Shipbuilding & Dry Dock Company, has a length overall of 34½ feet, a diameter of 15 feet, and is capable of withstanding an inside working pressure of 300 pounds per square inch and a test pressure of 450 pounds per square inch. Under normal conditions, the air will be forced through the wind tunnel at a speed of 240 feet per second; and the models will be tested at pressures of from 20 to 25 atmospheres—pressures to which airplanes are subjected in flight.

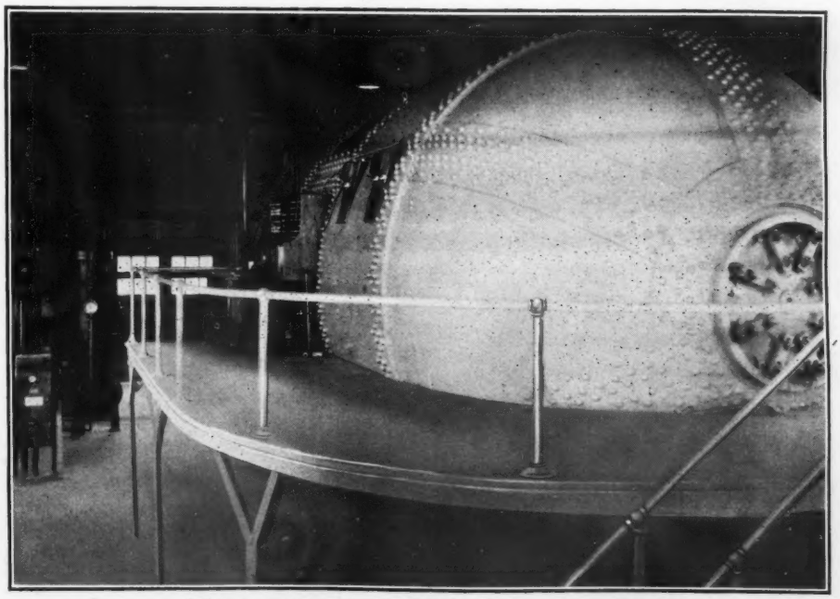
In the older order of wind tunnel, the model to be tested is suspended from a balance in the tube, through which air at a velocity of about 60 miles an hour is then forced. The behavior of the model under the prevailing conditions is recorded, and the resultant figures indicate the fitness or the unfitness of the design. Students of aerodynamics have been prone to doubt the capability of this type of wind tunnel to simulate the conditions to which flying machines are exposed when aloft.

The wind tunnel at Langley Field is based on the theory that by compressing the normal air we breathe to pressures of from 20 to 25 atmospheres it is possible to compensate for the difference in results obtained in the laboratory with small-scale models and those secured by full-sized airplanes in actual flight. The models used for test purposes are built on a scale of 2 feet to 50 feet.

The operation of the balance—from which the model is suspended in the wind tunnel—at first offered difficulties, but these are being surmounted by means of electrical controls. The balance consists principally of a built-up aluminum ring, which completely surrounds the experimental chamber; and the forces exerted against this ring are measured by balance beams with motor-driven weights. This instrument is sensitive to variations ranging all the way from .176 ounces to 1,100 pounds. In addition, a high-pressure manometer was designed capable of withstanding a pressure of 20 atmospheres.

Before the plans for the new wind tunnel were completed, other mediums than air for testing the miniature 'planes were suggested. All of these, however, were rejected in favor of compressed air, inasmuch as the density of the latter increases with compression while its viscosity remains constant—qualities most to be desired for the purpose of simulating service conditions. According to Max Munk, of the National Advisory Committee on Aeronautics, "Tests in the new wind tunnel will give information concerning those questions which could not be solved with the present tunnels because of the exaggerated effect of viscosity. The new type of tunnel is free of the uncertain characteristics of the older type; and it will make unnecessary many full-flight tests. It therefore marks a step in the right direction."

A brief reference to the development of methods for testing models of airplanes in whole or in part should not be out of place here. The first attempts in this direction involved the moving of a model through stationary air either along a straight or a revolving course. Subsequently, the models were supended and the air was permitted to flow past them, as is the common practice today. Originally, the experimental plants were very modest affairs, tucked away perhaps in the corner of a laboratory, while those in use at the present time are of splendid proportions. Take, for example, the wind tunnel at McCook Field, Dayton, Ohio. It is 96 feet long and requires the exclusive use of a standard 140-foot hangar. The tunnel recently completed for the French army at Issy-les-Moulineaux, outside of Paris, which is but a part of a large



Official photograph, National Advisory Committee for Aeronautics.

This compressed air wind tunnel enables the man in the laboratory to test airplane models under conditions simulating the free flight of full-sized machines. The observer takes his readings at the desk seen in the middle of the platform.

aerodynamic testing plant, is 110 feet long and occupies an entire building.

But of wind tunnels of this kind the National Advisory Committee on Aeronautics says: "The results with this type of wind tunnel are of very great value and, at the present time, are the chief source of information for the aircraft designer. However, there are certain critics who declare that the results of wind-tunnel tests are valueless for purposes of designing. Indeed, justification for such an opinion is not wholly lacking. There is, in fact, no exact relation between the motion of air around a small airplane model and that around a full-sized airplane. Sometimes the results of the tests on models agree with those observed with the airplane itself; but important cases are known where the two did not agree. Further, there are questions whose answers it is most important for the designer to know, and yet the answers deduced from tests of models in wind tunnels might be absolutely wrong. There is always a measure of uncertainty connected with such tests, because one is never quite sure whether or not the results thus obtained can be applied to full-sized bodies."

Hence, the development of the massive, steel testing chamber in which, because of the compression of the air, conditions can be brought about more nearly like those encountered by airplanes aloft.

HANDY SMALL PORTABLE NOW AVAILABLE

SINCE the advent of the portable air compressor, and the resulting widespread demand for pneumatic labor-aiding devices on outdoor jobs, a great need has come to be felt for a small, moderately priced, portable compressor of a really modern design. Such a machine has been developed, and is now being offered by the Ingersoll-Rand Company, 11 Broadway, New York.

This small portable, designated as the 4¼x4-inch Type Twenty, has a piston displacement of 60 cubic feet per minute, and is built along the same lines as the larger Type Twenty. All the desirable features of the larger units are retained—that is, duplex, vertical compressor, direct connected to a 4-cylinder, 4-cycle, tractor-type gasoline engine; enclosed construction; circulating water-cooling system for engine and compressor with sectionalized radiator, fan, and pump; compressor regulator and engine control for reducing speed during unloaded periods; 1-piece, cast-steel frame; sheet-steel roof; and removable side doors.

This Type Twenty portable opens up a new field. Its moderate cost makes it possible and decidedly profitable to use labor-aiding pneumatic equipment for work which was formerly considered too small to warrant the purchase of a compressor. Every city and town, as well as municipally or privately owned utilities should have such a machine. It will supply the necessary air for operating a paving breaker, "Jackhamer" rock drill, or other pneumatic tools for making road and paving repairs, for digging pipe trenches, for calking pipe, etc.

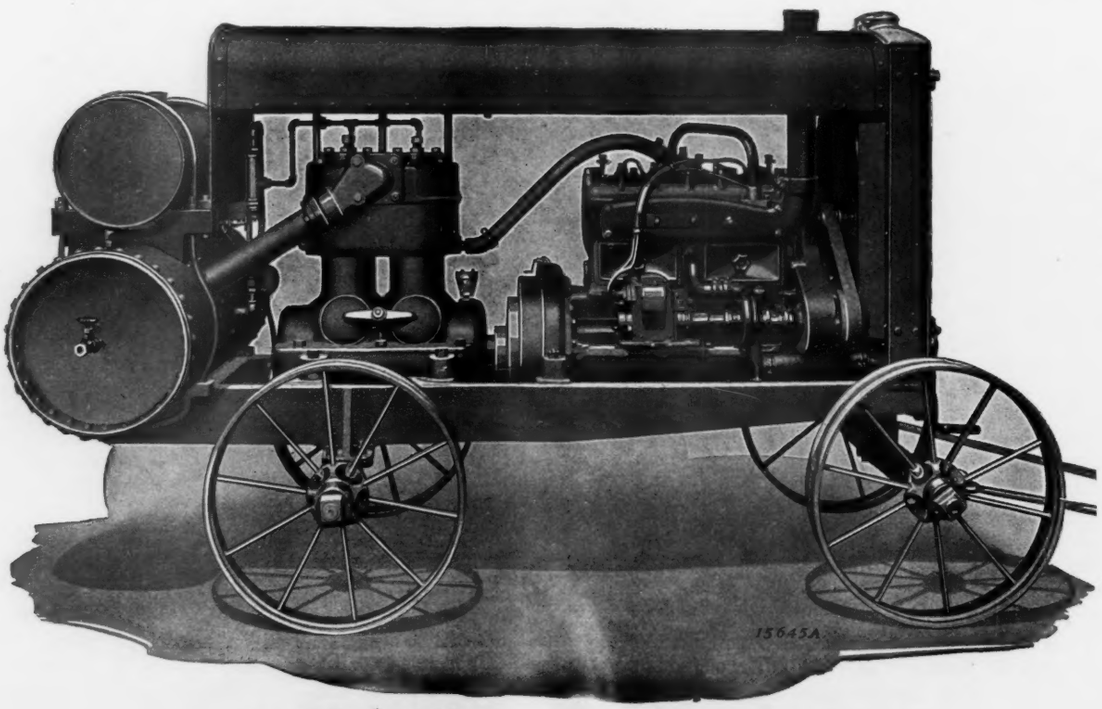
Industrial plants, having a central stationary air compressor, would do well to add a portable to their equipment. Such a unit, it is claimed, will more than pay for itself when employed in connection with structural and repair work and in supplying air for the many odd jobs of painting, cleaning, etc., that are always to be done. A compressor of this kind can be moved from one job to another and can be used in places where air lines are not installed and where it would be too expensive to put them in temporarily. The new 4¼x4-inch Type Twenty can be furnished with any one of a variety of mountings: steel wheels and axles; wooden artillery wheels with solid rubber tires and steel axles; or with a Ford truck. Skids for mounting it in a car or truck are also obtainable. In general service, this gasoline-engine-driven portable can operate the following tools: One BAR-33 "Jackhamer;" or one CC-25 paving breaker; or one 56-H clay or trench digger; or two 22-SR backfill tampers; or two 2-S calking or chipping hammers; or one No. 90 riveting hammer.

The larger Ingersoll-Rand portable compressors of which there are four in number, have piston displacements of 91, 160, 210, and 250 cubic feet of free air per minute.

RULES OF THE ROAD IN JAPAN

THE rules of the road relating to automobile traffic in Japan have been translated into English, and that rendering is quoted here with all its delightful oriental flavor.

"At the rise of the hand of a policeman, stop rapidly. Do not pass him by or otherwise disrespect him. Whenever a passenger of the foot hove in sight, tootle the horn trumpet to him melodiously at first. If he still obstacles your passage, tootle him with vigor and express by word of the mouth the warning, 'Hi, Hi'. Beware of the wandering horse that he shall not take fright as you pass him. Do not explode the exhaust box at him. Go soothingly by, or stop by the roadside till he pass away. Give big space to the festive dog that make sport in the roadway. Avoid entanglement of dog with your wheelspokes. Go soothingly on the grease-mud, as there lurk the skin demon. Press the brake of the foot as you roll around the corners, and save the collapse and tieup."



New Ingersoll-Rand, 4¼x4-inch, Type Twenty, portable air compressor.